Carry-Along Trade*

Andrew B. Bernard†
Tuck School of Business at Dartmouth, CEPR & NBER

Emily J. Blanchard‡
Tuck School of Business at Dartmouth & CEPR

Ilke Van Beveren§
Statistics Netherlands,
University of Leuven & National Bank of Belgium

Hylke Vandenbussche¶
University of Leuven,
National Bank of Belgium, & CEPR

September 2017

Abstract

Large multi-product firms dominate international trade flows. Using novel linked production and export data at the firm-product level, we find that the overwhelming majority of manufacturing firms export products that they do not produce. Three quarters of the exported products and thirty percent of export value from Belgian manufacturers are in goods that are not produced by the firm, so-called Carry-Along Trade (CAT). The number of CAT products is strongly increasing in firm productivity while the number of produced products that are exported is weakly increasing in firm productivity. We propose a general model of production and sourcing at multi-product firms and explore new demand- and supply-side modeling features capable of generating predictions consistent with the empirical findings. Export price data and company interviews offer suggestive evidence for the presence of demand-scope complementarities.

Keywords: heterogeneous firms, multi-product firms, exporting, sourcing, productivity, intermediation, demand-scope complementarity
JEL codes: F12, F13, F14, L11

*A special thanks goes to Jean-Marc Troch at the National Bank of Belgium for assistance and help with the data. We are also grateful to Stefania Garetto, David Green, and numerous seminar participants for helpful comments, Christophe Piette and Kris de Spiegelaere for data clarifications and Danny Delcambre for supplementary files and help with the CN concordance. Björn Arnarson, Virginia di Nino, Valerie Smeets, Frederic Warzynski and Emmanuel Milet generously shared their results, Vandenbussche thanks Program Financing and Methusalem of Leuven for support. This paper was written while Van Beveren and Vandenbussche were visiting the National Bank of Belgium. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Statistics Netherlands, National Bank of Belgium, the NBER or the CEPR. All remaining errors are our own.

†100 Tuck Hall, Hanover, NH 03755, USA, *tel:* +1 603 646 0302, *email:* andrew.b.bernard@tuck.dartmouth.edu

‡100 Tuck Hall, Hanover, NH 03755, USA, *tel:* +1 603 646 8962, *email:* emily.j.blanchard@tuck.dartmouth.edu

§CBS-weg 11, 6401 CZ Heerlen, Netherlands., *tel:* 31(0)45 570 6349, *email:* ivbn@cbs.nl

¶Naamsestraat 69, 2000 Leuven, Belgium, *tel*: +32 16 32 69 20, *email*: hylke.vandenbussche@kuleuven.be

1 Introduction

Exports are well-known to be highly concentrated in a relatively small number of firms that ship many products overseas. Existing models of multi-product exporters describe firms that make one or more products and ship some or all of those products abroad.[1] We present the first evidence that these multi-product exporters are, in fact, not making the majority of the products that they export. Instead, the most productive firms sell more products to the market because they both make more *and source more* products. In this paper, we explore this phenomenon empirically and theoretically.

Our findings alter the established perception of what manufacturing firms do and the role they play in the global marketplace. Using new data that link domestic production and international trade by manufacturing firms at the firm-product level, we document the fact that a large majority of manufacturing exporters export many products that they do not produce. In addition, a smaller set of the largest manufacturing firms produce goods where they export more than they produce. We refer to these complementary export activities together as Carry-Along Trade (CAT).[2]

The practice of Carry-Along Trade is widespread, occurring in virtually every product category and in nearly ninety percent of the firms in our sample. In our sample, these CAT exports constitute at least 5 percent of total firm exports for more than two-thirds of firms and make up at least 10 percent of exports in more than 60 percent of firms.[3] Carry-Along Trade is also most prevalent among more productive firms. Our results confirm earlier findings that there is a positive relationship between firm productivity and the number of products produced and (especially) exported by multi-product firms.[4] But we find that most of the increase in export scope is due to a strong positive relationship between firm productivity and exports of *sourced* products (CAT). Both the total number of products and the share of CAT products in total exported products are rising in firm productivity.[5] And although the majority of export value *does* come from products that are made in-house by the firm, consistent with the definition of these firms as manufacturers, nearly a third of total export value consists of CAT. Rather than an ancillary, add-on practice, Carry-Along Trade

[1]Bernard et al. (2007) and Mayer and Ottaviano (2008) provide evidence on the importance of multi-product exporters. Theoretical models of multi-product exporting firms include Eckel and Neary (2010), Bernard et al. (2011), Arkolakis et al. (2015) and Mayer et al. (2014).

[2]We use the term Carry-Along Trade instead of "export resales" to refer to the sale of non-produced goods. The term "resales" has a specific accounting definition in firm reports, while our CAT measure is the *calculated* difference between production and export sales at the firm-product level, and is not derived from *reported* resales in the financial accounts.

[3]See Table 2.

[4]See Bernard et al. (2011), Mayer et al. (2014), and Arkolakis et al. (2015).

[5]Our findings from the Belgian data have been recently replicated for firms in Italy [Di Nino (2015)], Sweden [Arnarson (2016)], and Denmark [Abreha et al. (2013)], all of which exhibit the same patterns of CAT activity in either domestic or export markets. In the French manufacturing sector in 2005, 49 percent of firms report sales of goods they do not produce, accounting for 39 percent of their total revenue. We thank Emmanuel Milet for this tabulation.

appears to be a systematic and quantitatively important feature of firms' cross border activities.

To identify and understand the potential explanations that could be driving the CAT phenomenon, we extend a general model of multi-product producers to include sourcing from arms-length suppliers. The model features firms that choose the optimal *product scope*, i.e. how many products to sell to the market and at what prices and quantities, and face a *make or source* decision for each product, i.e. the question of whether to produce goods in-house or source them from outside suppliers (CAT).

We demonstrate that in order to rationalize the patterns in the data, there must be new demand or supply-side mechanisms that generate complementarities between firm productivity and sourcing. One potential theoretical explanation, which we call *demand-scope complementarity,* captures the possibility that expanding the set of products that a firm offers to the market could increase demand for all of the firm's existing products.[6] If demand-scope complementarity is sufficiently strong, our model predicts a positive relationship between firm productivity and the number of both produced and sourced products, consistent with the data. A second candidate demand-side explanation is that the most productive firms also are the most "popular", enjoying a positive firm-level demand shifter that enables them to sell more regular and CAT products to the market in equilibrium.

On the supply side, our theory indicates that if more efficient producers also have more efficient distribution networks or if there are increasing returns to distribution, the model can generate empirical predictions consistent with the data where, again, the most productive firms sell more produced and more sourced products to the market. Alternatively, if more productive manufacturers also have lower marginal costs of sourcing (but not too low), they will export a greater range of both produced and sourced products to the market in equilibrium.

While each of these potential demand- and supply-side modeling features constitutes a plausible explanation for Carry-Along Trade in principle, we find suggestive evidence of a demand-side mechanism, and particularly for the possibility of demand-scope complementarity. Exploiting variation in export prices across destination markets within each firm-product, we demonstrate that firms charge higher prices in markets where their total product scope is higher, all else equal. This result points to a positive relationship between productivity and demand (which would push prices up) rather than supply (which would lower prices). Comparing the pattern of co-production and co-exporting across sectors reveals that the co-exports of CAT products are largely divorced from production patterns within firms, which offers indirect evidence in favor of demand-side explanations over a supply-driven mechanism. These empirical findings are consistent with documented company interviews, in which managers report the importance of bundling their manufactured goods with complementary sourced products to meet and enhance customer demand. The combined evidence suggests that demand-side drivers, including demand-scope complementarities, are likely sources of

[6] For instance, a preference for "one-stop shopping" could generate demand of this form (Oxenfeldt (1966)).

the CAT phenomenon.

Whatever its underlying cause, the widespread practice of Carry-Along Trade complicates how we model and measure the consequences of globalization. Recent research has begun to incorporate global value chains, i.e. sequences of imported inputs, into the analysis of trade and trade policy. The prevalence of CAT is a different and as yet unmeasured component of global trade networks where large manufacturing exporters are shipping *final* goods produced by other firms across borders. In light of our findings that the vast majority of exporting manufactures are not making all of the goods that they produce, the sources of firm-size disparity, measurement of domestic value-added, and even the implications of trade shocks are all subject to reexamination.

The Carry-Along Trade phenomenon also puts new emphasis on the importance of supply networks in exporting, not only through inputs to production, but also through sourced final goods. To the extent that sourcing plays a central role in firms' ability to serve customers, access to suppliers may be a crucial prerequisite for firm success. Given recent evidence that CAT is important for Italian, Danish, French, Swedish as well as Belgian manufacturing firms, it seems plausible that the ability to source within the common market may be playing an important role in the export successes of these European countries. At the same time, to the extent that the output of small and medium enterprises is exported by larger manufacturing firms, the resulting concentration of exports increases the role of large firms in the transmission of shocks across borders,[7] as seemingly-domestic producers may in reality already be reaching foreign markets (and thus exposed to foreign shocks) through CAT.[8]

This paper is related to several diverse areas of research. At its core, the paper is about multi-product exporting firms. The addition of sourced goods extends the recent theoretical literature on multi-product exporting firms, e.g. Eckel and Neary (2010), Bernard et al. (2011), Arkolakis et al. (2015), and Mayer et al. (2014). The relative ability of more productive firms to source and produce more products provides an additional explanation for the high concentration of exports (and imports) in the largest firms as documented by Mayer and Ottaviano (2008) and Bernard et al. (2009a).

Also closely related is the important recent work on domestic firms by Atalay et al. (2014), who find that firm ownership structures diverge from traditional input-output linkages. In light of this finding, they argue that intangible firm characteristics (e.g. management practice or branding) may tie seemingly-unrelated products together under a common firm-level umbrella. Our findings about the importance of CAT suggest that these intangibles may be driving firm success in both their own production and in their sourcing from outside firms. Our results also echo the important recent

[7] See e.g. Gabaix (2011), Acemoglu et al. (2012), Magerman et al. (2016).

[8] By the same logic, trade barriers may indirectly apply to seemingly-domestic firms through CAT-supply relationships. Moreover, if demand-scope complementarities are an important feature of customer preferences, then exporting firms' market access may depend on trade barriers for a bundle of products. Evaluating tariffs or non-tariff barriers product-by-product could therefore misrepresent the de facto impediments to market entry.

work by Foster et al. (2012) and De Loecker et al. (2016) who emphasize the central role played by demand in explaining differences in firm performance.

Another recent literature explores the role of pure intermediaries in international trade, e.g. Bernard et al. (2010a), Ahn et al. (2011), Akerman (forthcoming) and Bernard et al. (2015). Our findings suggest that manufacturing firms themselves are acting as de facto intermediaries for a large number of products and a large volume of exports. While our focus is on the decision to produce or source goods for the final customer, recent papers such as Antràs et al. (forthcoming) and Bernard et al. (2014a) model the related decision to source intermediates from international and domestic suppliers.

Finally, this work recalls a long tradition in the industrial organization literature exploring how firms with market power can increase their profits by tying or 'bundling' sales of multiple products. This literature dates at least to Cournot (1838) and includes key contributions by Stigler (1963); Adams and Yellen (1976); McAfee et al. (1989); and Whinston (1990). Although our model maintains the assumption of atomistic firms, strategic tie-in or bundling by oligopolistic firms could induce a form of demand-scope complementarity and generate similar predictions to the demand-driven model we examine.

The rest of the paper is organized as follows. In Section 2, we explore the relationship between domestic production and exports in a sample of Belgian manufacturing firms and examine how firm characteristics vary with the number of exported products. Section 3 introduces the definition of Carry-Along Trade and documents that CAT is widespread and important for firms, products and aggregate export value. In Section 6, we examine the relationship between CAT and firm characteristics. Section 7 presents a simple model of multi-product firms and sourced products and highlights the demand and supply-side features that are capable of matching the stylized facts about CAT. We consider empirical implications of the theoretical framework in Section 8 and discuss the broader implications of our findings in Section 9. The final section concludes.

2 Manufacturing, Domestic Production and Exports

To develop a more complete understanding of the relationship between a firm's production and exports, we link data from two different sources: one that records activities related to a firm's domestic production by product and another that tracks a firm's exports by product. The Belgian export data are obtained from the National Bank of Belgium's Trade Database, which covers the entire population of recorded trade flows. The export data are recorded at the year-firm-product-country level, i.e. they provide information on firm-level export flows by 8-digit Combined Nomenclature (CN8) product and by destination country. In the empirical work we consider 6-digit product categories to facilitate comparison with datasets from other countries and to reduce the likelihood of product misclassification.[9]

We exclude transactions that do not involve a "transfer of ownership with compensation". This means that we omit transaction flows such as re-exports, the return, replacement and repair of goods and transactions without compensation, e.g. government support, processing or repair transactions, etc. We further exclude export product classes that do not correspond to activities in the production data.[10] The remaining transactions cover more than 73 percent of total reported export value for 2005.

We focus on a sample of Belgian manufacturing firms where we can link production and exports at the firm-product level for 2005. The focus on manufacturing exporters is driven by existing multi-product theory models, which assume that a producing, or manufacturing, firm produces one or more products and exports some or all of those produced products.[11] The theoretical literature on multi-product exporters is largely related to the joint production and export decisions of the firm and typically does not consider the possibility that manufacturing firms will sell sourced products to their customers. The existing empirical literature on multi-product exporters usually examines trade data alone or trade and production data separately.[12] This study is the first to link export data to production data at the firm-product level.

The firm-product production data come from the Prodcom database. The Prodcom survey is used by Eurostat to collect comparable industrial production statistics across EU countries. Two main types of firms are required to declare their domestic production activities at the firm-product level and thus are present in the database: (1) firms with a primary activity in manufacturing employing at least ten employees and (2) firms with a primary activity outside manufacturing (but with manufacturing production) employing more than twenty employees. The variable we use to quantify domestic production by product is firm-product sales of domestically produced goods rather than the value of physical production in that year. Exports and firm-product sales thus both correspond to transactions executed within the year, which avoids issues of inventories and production in prior years. Domestic production activities are reported in Prodcom 8-digit codes (PC8), unlike the export data, which use the 8-digit CN classification system (CN8). While the CN8 and PC8 classifications are designed to be similar and to allow product-level comparisons (see the data appendix and Table 3), the level of detail of the PC8 is lower than that of the CN8. We concord the two product classifications into categories that correspond as closely as possible

[9] The CN classification is available at the Eurostat Ramon server: http://ec.europa.eu/eurostat/ramon/ .

[10] For examples of these types of products and for a more complete discussion of the issues in combining EU production and trade data, see Van Beveren et al. (2012).

[11] For recent work on trade intermediaries that highlights the role of non-manufacturing firms in aggregate exports, see Bernard et al. (2010a), Ahn et al. (2011), Akerman (forthcoming) and Bernard et al. (2015); in these papers, manufacturing firms either export directly or through a non-manufacturing intermediary.

[12] An exception is Iacovone and Javorcik (2010) who consider both production and exports in Mexico. Their data come from a Monthly Industrial Survey that is unlikely to record information about exports of goods that are not produced by the firm.

to six-digit Harmonized System products (HS6) to reduce potential misclassification and to allow more direct comparisons with data from other countries.[13] Henceforth, we refer to the 6-digit data as HS6+. Overall, there are 2,923 HS6+ products that feature in our data (either domestically produced or exported)

After linking the export and production datasets we have a sample of 3,631 exporting firms with €85.0billion of exports in over 192,000 firm-product-country transactions in 2005. Among firms with a primary 2-digit NACE classification in manufacturing, the Prodcom sample accounts for 58 percent of exporting firms and 91 percent of total exports.[14] These firms represent 17 percent of Belgian exporters and 43 percent of total Belgian exports in these products. Table 1 reports summary statistics for these firms by the number of HS6+ products exported. Given the selection criteria, it is not surprising to find that firms in this sample are larger in terms of the number of products exported, total value of exports, and average number of destinations than the entire universe of Belgian exporting firms (see Bernard et al. (2014b)).

The last three columns of Table 1 use balance sheet data to evaluate the link between the number of exported products and indicators of firm-level productivity and size.[15] We confirm findings from other research that firm productivity, value-added and employment are all higher for firms that export more products.

2.1 Exported versus produced products

The most unusual finding from this simple overview comes in column 2 of Table 1. Except for the category of single-product exporters, firms in every other category report greater numbers of products exported than products produced.[16] Multi-product exporters are also multi-product domestic producers but the number of exported products increases much more rapidly than the number of produced products, as seen in Figure 1.

It is this simple fact that manufacturing firms export more products than they produce that we

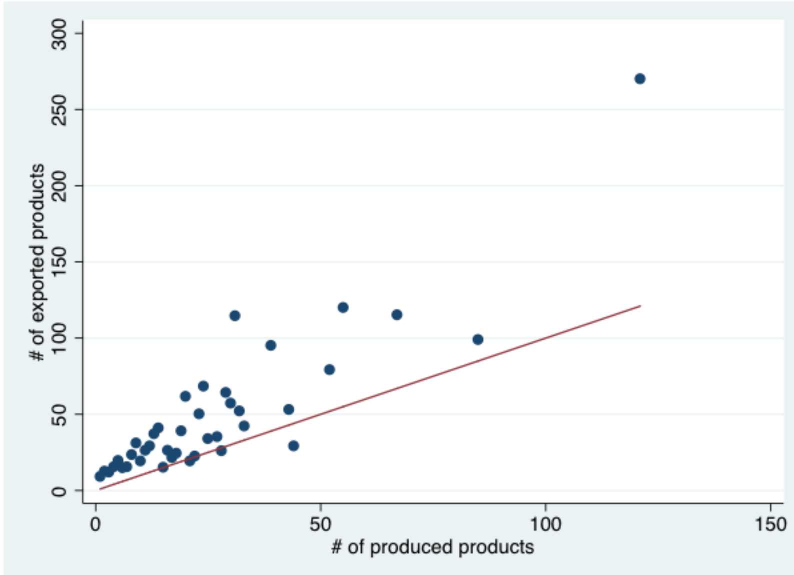
[13]Every product in our empirical analysis is either a unique HS6 category or a collection of related HS6 categories. In particular, there are 9,157 CN8 codes and 4,784 HS6 codes compared to 4,220 PC8 codes. Out of the 4,220 PC8 codes, 2,140 have a one-to-one match with a single HS6 product. The remaining PC8 codes are many-to-one mappings from PC8 to HS6 (423 HS6 codes), one-to-many mappings (1750 HS6 codes) or many-to-many mappings (471 HS6 codes).

[14]While all the firms in the Prodcom sample report positive manufacturing production, 521 exporting firms have a non-manufacturing sector as their primary NACE 2-digit activity in the annual accounts data. Our results on CAT trade are not affected by the inclusion or exclusion of these firms. Another 1,834 firms with positive manufacturing in the Prodcom data are non-exporters.

[15]Selection on availability of firm-level characteristics such as employment, value-added, tangible fixed assets etc. imposes another restriction on the sample selection, i.e. only those firms with positive values for all firm characteristics can be included in the analysis. To obtain comparable levels of total factor productivity (TFP) across firms, we apply the Caves et al. (1982) methodology. Hence, TFP is calculated as an index, calculated by comparing each firm to a hypothetical firm, where the hypothetical firm is defined as the average over all firms in a two-digit NACE sector.

[16]Production refers to sales of produced goods rather than the physical creation of the goods during the year. This concept of produced sales corresponds more closely to the recorded export numbers and helps to avoid problems of stockpiling and inventories.

Figure 1: Exported Products and Produced Products, 2005



Notes: Each point indicates the average number of exported products for firms producing that number of goods. The line indicates equal numbers of exported and produced goods.

explore for the rest of the paper. The next section develops a set of facts about the relationship between domestic production and exports at the firm-product level, discusses possible explanations including data error, explores the robustness of the findings, and examines the relationship between firm productivity and trade costs on the margins of trade for different types of products: those produced by the firm and exported and those exported but not produced by the firm.[17]

3 Carry-Along Trade

To guide our exploration of what firms make and what they sell or export, we first define Carry-Along Trade for both products and firms. Products fall into three mutually-exclusive categories at the firm-product level: (1) *non-exported* firm-products which are reported as produced by the firm but are not recorded as exports; (2) *regular* export firm-products which are products both reported as produced and exported by the firm *and* where the value of exports is less than or equal to the value of production; (3) *Carry-Along Trade* firm-products which are products where the value of exports is greater than the value of production by the firm,

$$\#\text{exported products} = \#\text{regular} + \#CAT.$$

[17]Our data do not distinguish whether these sourced products are produced by other domestic firms at home or by firms abroad, i.e. whether this phenomenon is part of domestic or global supply chains.

Carry-Along Trade (*CAT*) firm-products can be further divided into two non-overlapping, exhaustive categories: (3a) *pure-CAT* firm-products where the firm export value is positive but there is no recorded production in that product (domestic produced $\text{sales}_{fp} = 0$), and (3b) *mixed-CAT* firm-products where the firm reports positive production and exports and the value of exports is greater than that of production. The number of exported products for each firm is the sum of types (2)+(3) while the number of produced products is the sum of types (1)+(2)+(3b). Firm exports can be split into produced exports and sourced (or non-produced) exports. Produced export value is the sum of exports of regular firm-products and the value of mixed-CAT firm-products that are produced by the firm. Sourced exports equal the sum of exports of pure-CAT firm-products and the portion of mixed-CAT firm-products that are sourced by the firm.

In column 1 of Table 2 we explore Carry-Along Trade at the HS6+ level. Of the 3,631 exporting firms in the concorded dataset, the large majority are CAT exporters: 3,233 firms or 89.0 percent of the sample. Among these "CAT firms", most (3,177) export at least one pure-CAT product, i.e. a product for which they report no domestic production. CAT exports make up at least 5 percent (10 percent) of total firm exports in 76 percent (69 percent) of CAT firms, or 67 percent (62 percent) of the total sample. Carry-Along Trade is not concentrated in a particular industry or type of product. Of the 2,858 total unique HS6+ products, 2,822 (98.7 percent) are reported as Carry-Along Trade by at least one firm.

While most firms export at least one CAT product and most products are exported as CAT by at least one firm, the share of CAT exports in the total value of exports is lower. Sourced exports are €25.4billion, just under 30 percent of total exports for all firms in the sample. Of this total, pure-CAT products account for 96 percent of the number of CAT products and 74 percent of the value of sourced exports.

These results suggest that the traditional understanding of a manufacturing exporter that produces products and exports some or all of them overlooks an important aspect of firms' cross border activities. The large majority of products exported by the firm are not made by the firm and these sourced products account for a sizable fraction of firm export value.

4 Data Issues

Misclassification. To compare production and exports at the level of the firm-product, one ideally would like to have data from a single source with both production and exports recorded in a common classification system. Since the export and production data come from distinct sources, it is possible that the same product might be classified in different 8-digit codes for the export records and production records. If there is some ambiguity about the correct classification for a product, different individuals filling out the different forms and surveys may choose related but distinct product classifications for the export and product information. Even the same individual faced with different product descriptions might record the same good in two different categories.

This can be seen in the context of a specific example from the CN and PC Codes and Descriptions for "Sweet Biscuits" in Table 3. Items in the HS6 category of "Sweet biscuits" can be classified into five different CN8 categories depending on whether they are coated with chocolate/cocoa, the weight of the immediate packaging, the level of the milk-fat content, and whether or not they are sandwich biscuits. There are two PC8 codes that encompass sweet biscuits based on the chocolate/cocoa covering. The CN8 codes map fairly directly into the PC8 codes but mistakes in classification are still possible. In such a case a slightly more aggregate view of the data will merge related product codes and eliminate spurious CAT exports. Our choice of a six-digit level of aggregation should remove many such cases of spurious misclassification.

In the remaining columns of Table 2, we examine how the prevalence of CAT exports changes at different levels of aggregation. Column 2 reports the same numbers after aggregating both the production and the export data to the coarser HS 4-digit level. This represents a substantial reduction in the number of categories as there are now only 1,012 "products". Even at this more aggregate level we find that CAT firms and products are pervasive. CAT firm-products still represent the preponderance (85 percent) of exported goods, 83 percent of firms export at least one pure-CAT product and 98 percent of products are exported as a CAT product by at least one firm. Aggregating the product categories does reduce the value of sourced exports by more than 20 percent to €19.6 billion.

Aggregating further to the 2-digit level (90 "products") continues to reduce the number of firms engaged in CAT and the value of CAT exports. However, even with extremely aggregated 2-digit categories, 2,669 firms (73 percent) report exporting in a category where they report no production; the value of sourced products is still more than 16 percent of the total export value of these manufacturing firms. Our conclusion from this aggregation exercise is that product misclassification might play a role in some CAT exports but the phenomenon is widespread across firms and products and represents a substantial fraction of exports by manufacturing firms.

Sample Selection. As an additional check of the robustness of the main facts about Carry-Along Trade, we consider a range of different samples of the data as reported in Table 4. To account for the concern that firms with large non-manufacturing operations might be distorting the results, we select only firms with a primary activity in manufacturing and find no differences in the importance of CAT across firms, products or the value of exports. Dropping all firms with activities outside manufacturing also does not change the results.[18] Another possibility is that firms are part of larger domestic or multinational groups and might be exporting products made by other companies in the group. Dropping firms in either domestic or foreign groups does not appreciably

[18]The results are also not driven by the presence of any particular sector. For example, dropping firms in food-related manufacturing (a sector where large wholesaler/retailers are likely to perform some manufacturing) does not alter the results.

reduce the presence of CAT.[19]

Concordances. Another potential data error comes from combining six-digit products into larger categories. Limiting the analysis to products with a one-to-one concordance between the two 8-digit classification systems again does not noticeably alter the fractions of CAT exporters and CAT products or the CAT share of export value. To avoid concerns that CAT is primarily the result of re-exporting that is not correctly captured by customs procedures, we drop products that are also imported by the firm. Again the results are not altered. The findings are also robust to a change in the definition of CAT at the firm-product level, excluding the possibility that small differences in reported production and trade numbers are generating CAT.[20]

While the possibility remains that some fraction of CAT trade appears in the data due to misreporting or other measurement issues, the pervasive nature of CAT across firms and products is a robust stylized fact.

5 Company interviews

To learn more about the origins of CAT, we interviewed more than 20 exporting firms in a variety of sectors in the US and Belgium.[21] Every firm reported exporting products that it did not make (pure CAT) and several firms discussed using outside suppliers to obtain additional quantities of products that were produced in-house (mixed CAT). Firms were most likely to describe CAT products as extending the range of products produced in-house to meet customer demand. However, we also found evidence for supply-side drivers of CAT as one firm with a specialized exporting technology (transporting frozen food), exported sourced products to fill containers and another firm exported locally-sourced customized containers to its foreign subsidiaries.

A fairly typical example of CAT exports comes from a firm we will call "Company A". Established more than 200 years ago, Company A is a manufacturing firm in the food sector that produces roasted coffee. Since the 1970s the company has specialized in the out-of-home (non-retail) market, supplying coffee, coffee systems, and coffee service to offices, hotels, restaurants, and events. Company A is a medium-sized company, but is one of the largest players in its segment in Belgium and a relatively large player in the European Union.[22] Coffee production is centered in Belgium and the firm exports its coffee to 25 countries, mainly within the European Union.

In addition to exporting its core product, roasted coffee, Company A exports a wide variety

[19] Multinational and foreign-owned firms are defined using the FDI survey (cfr. Data Appendix). Domestic groups are identified using ownership information fromBvDEP (2006).

[20] Firm-product exports are considered to be regular exports if the ratio of production to exports is greater than 0.99 and firm-product exports are consider to be pure CAT if the ratio is less than 0.01. Adjusting these cutoffs does not materially change the importance of CAT across firm and products.

[21] The firms were chosen based on our ability to gain access to senior management of manufacturing exporters and are not a representative sample.

[22] In 2005, Belgium was the fourth largest exporter of roasted coffee (faostat.fao.org).

of additional goods ranging from coffee vending machines, sugar, milk, cookies, tea, soup, plastic cups, and spoons to kitchenware (e.g. coffee cups). Company A produces only coffee in-house. The other products are sourced from external suppliers, i.e. these are (pure) Carry-Along Trade products. These CAT products are obtained from Belgian and foreign manufacturers depending on expedited availability and price. The firm normally exports CAT (sourced) products only to destinations where it exports coffee.[23]

Company A is not selling coffee, but rather is selling a bundle of products for the service of the coffee room. According to the firm, a characteristic of the out-of-home coffee market is that it is important to provide clients with a full service package (the complete coffee room); CAT products allow the firm to satisfy its clients' demand. The coffee room service package tends to be country-specific, depending on local coffee drinking habits. In some countries coffee tends to be served with cookies, while in other countries cookies are not part of the "coffee experience". The bundle thus is adapted according to the customer's and country's specific needs. We explore these demand-side explanations for CAT further in Section 7.2.

6 CAT, Margins of Trade, and Productivity

In this section, we follow the empirical strategy of Bernard et al. (2011) and relate the margins of firm trade to proxies for firm productivity. Total firm exports, X_f, can be decomposed into the number of distinct products exported, P_f, and the average exports per product, $\bar{X}_f$:

$$\begin{aligned} X_f &= P_f \bar{X}_f, \qquad (1) \\ \text{where } \bar{X}_f &= \frac{1}{P_f} \sum_p X_{pf}. \end{aligned}$$

Previous empirical work on US exporters has shown a strong positive correlation between measures of firm productivity and total exports as well as a positive relationship between productivity and the number of exported products (Bernard et al. (2011)).[24] These results also hold for total firm exports in our sample of Belgian manufacturing exporters. In panel A of Table 5 we report pooled cross-section regressions for 2005 of log firm exports and its two constituent components on log firm TFP and fixed effects for the major industry of the firm:

$$\ln Y_f = c + \beta \ln \text{Prod}_f + \psi_i + \varepsilon_f, \qquad (2)$$

where Y_f refers to the two components of the decomposition given by (1), i.e. P_f and $\bar{X}_f$. By construction, the specification only examines the relationship between productivity and exports for

[23] In the linked manufacturing-exporting data, we find that, within firms, the probability that a product is produced (rather than sourced) is increasing in the number of export destinations.

[24] We focus in this paper on the number of products and the average exports per product. Results including the number of destinations as an additional extensive margin do not change the main results and are available upon request.

current exporters. The results indicate that firm exports are strongly positively associated with firm productivity with an elasticity significantly greater than one. Looking at the extensive and intensive margins, we find large, positive, and significant coefficients for the number of products and the average value of exports per product. More productive firms export more products and ship more of each product abroad.

Our principal interest lies in the differential response of exports of produced and CAT firm-products. We compare exports of regular product and pure CAT products across firms with differing productivity. In panels B and C of Table 5 we report pooled cross-section regressions of log firm exports of type $j \in \{REG, pureCAT\}$ and its constituent components on a dummy for export type ($d_{pureCAT} = 1$ for pure CAT exports), a proxy for firm productivity, and an interaction term, including fixed effects for the major industry of the firm:

$$\ln Y_f^j = d_{pureCAT} + \beta \ln \text{Prod}_f + \gamma d_{pureCAT} \cdot \ln \text{Prod}_f + \psi_i + \varepsilon_f, \tag{3}$$

where Y_f^j refers to the two components of the decomposition given by (1), i.e. P_f^j and $\bar{X}_f^j$.

Panel B of Table 5 uses log TFP as the firm productivity measure while panel C uses log value-added per worker; the results are very similar for the two measures. Looking across the second row of coefficients in each panel, we find that the value of produced exports again increases in firm productivity. However, the rise in produced exports is due mostly to the rise in the average exports per product (intensive margin); the number of produced products (extensive margin) increases weakly with firm productivity.

While exports of pure CAT products are significantly lower than produced exports within the firm (the pure CAT dummy is negative and significant), pure CAT exports also increase at a similar or slightly lower rate compared to regular (produced) exports as firm productivity rises.[25] The levels and the response to firm productivity are quite different across the extensive and intensive margins. The number of CAT products is greater than produced products and increases much faster in firm productivity (column 2). The share of CAT products in total exported products rises as firm productivity increases. In contrast, average shipment size for CAT products is lower than that for produced products and increases at a much slower rate as firm productivity rises.

While the value of both produced and pure CAT exports increases with firm productivity, there are notable differences between the responses of produced and sourced products. The increase in produced export value comes largely through sizable increases in average shipments of each product and much less through an increase in the number of produced products that are exported. For Carry-Along Trade, higher productivity is associated with increased export levels, but the increase is split roughly evenly between rising numbers of pure CAT products and an increase in average

[25] The relationship between firm productivity and CAT exports can be obtained by summing the coefficient on the productivity measure and that on the interaction term.

export value. The overall increase in exported products at more productive firms is due mostly to adjustments in the number of pure CAT products.[26]

One major potential concern stems from the use of log TFP or log value-added per worker as the proxy for firm productivity, since revenue-based measures of TFP confound both quantity-based productivity and firm-level markups.[27] Table 6 therefore repeats the regression with the number of export products as the dependent variable with a set of additional firm characteristics that are likely to be positively correlated with underlying productive efficiency. For the first column, we create a quantity-based proxy of firm productivity: first we calculate firm output relative to the industry average output for the same product, $\ln q_{fp} - \frac{1}{n}\sum_f \ln q_{fp}$. We then take the weighted sum across the set of products produced by the firm to create each firm's quantity-size production, where the weights are the shares of the products in total firm revenue using average product prices (i.e. sales divided by output for all firms that made the product).[28] The results in column 1 confirm the earlier findings that both the number of produced export products and the number of pure CAT export products are increasing in the level of the firm productivity proxy. In addition, the number of pure CAT products increases much more rapidly with the productivity proxy than does the number of produced export products. In the remaining columns, we also consider as proxies the total value of production by the firm, the value of production of the largest product, total exports, exports of the largest product, and a measure of production worker employment. The results for these proxies remain similar throughout.

Together, the evidence paints a clear picture in which the most productive manufacturing exporters make and source more products in equilibrium. The next section explores the potential explanations for this Carry-Along Trade phenomenon.

7 A Flexible Model of Multi-Product Firms and Sourcing

To our knowledge, the phenomenon of manufacturing firms exporting goods that they do not produce themselves is not present in either the theoretical or empirical literatures on international trade. While there has been work on the role of networks in facilitating trade, e.g. Rauch (2001), Rauch and Watson (2004) and Petropoulou (2011), and the presence of intermediaries in trade, e.g. Ahn et al. (2011) and Akerman (forthcoming), the typical assumption is that the intermediary is a non-

[26] Dropping firms whose CAT exports represent fewer than five percent of total exports does not change the results, i.e. the results are not being driven by "marginal" CAT exporters. The coefficients for specifications with mixed CAT products lie in between those for produced and pure CAT products. Including mixed CAT products does not change the findings.

[27] There are many issues in constructing measures of firm-level productivity. See Foster et al. (2008) for comparisons of quantity and revenue-based TFP and De Loecker (2011) and Bernard et al. (2009b) for some of the difficulties in constructing productivity measures for multi-product firms. The presence of sourced products adds yet another set of potential problems in multi-factor productivity measurement.

[28] Using the average price for the product reduces the possibility that firm-specific markups are affecting the quantity measure.

producing firm. Our work differs from and complements existing research by exploring the role of sourced and produced products in the manufacturing exporter's portfolio. In this section, we present a flexible model of multi-product exporters that can explain the presence of CAT and its relationship to firm productivity.

Our goal is to construct a framework that identifies the potential mechanisms and motivations underlying the patterns we observe in the data. Specifically, we are looking for theoretical explanations of Carry-Along Trade that can generate three key predictions consistent with what we observe: first, that regular (produced) product scope and output per product increase with firm productivity; second, that CAT (sourced) product scope and output per product *also* increase with firm productivity; and third, that CAT product scope is *more* responsive to firm productivity than is regular product scope.

While the first prediction – that more productive firms will produce a greater number of products and sell higher volumes of each – will arise naturally in virtually any multi-product firm model, the second and third predictions are new and generally will not obtain under the assumptions customary to the heterogenous firms literature. Intuitively, there is a tension between firms' core productivity and sourcing. In typical models, more productive firms do more in equilibrium – they are the first to export, to engage in foreign investment, to undertake R&D, etc. – because core productivity and these additional extensive margin activities are complementary, or *supermodular*, in firm payoffs.[29] In contrast, sourcing is direct substitute for in-house production, which implies that sourcing is *submodular* with firm productivity: all else equal, the payoff from sourcing is lower for more productive firms. Because of this submodularity, we cannot simply "add sourcing" to an otherwise standard multi-product firm model if we want to explain why more productive firms make *and source* more products in equilibrium.

To this end, we design a new, flexible multi-product firm framework that is capable of generating predictions consistent with the evidence. We start with a basic model that maintains the customary supermodularity between regular product scope and firm productivity, so that more productive firms make and sell more of their own products in equilibrium. Adding sourcing via CAT, we then demonstrate that sufficient supermodularity in firm payoffs between total product scope and firm productivity can override the fundamental substitutability between in-house production and sourcing, as can certain assumptions over multi-dimensional firm heterogeneity, so that more productive firms also procure and sell more sourced products in equilibrium. Provided that the complementarity between firm productivity and total product scope is strong enough, more productive firms will sell a broader range, and higher per-product output, of both regular *and* CAT products in equilibrium, consistent with the empirical evidence. As long as these effects are strong enough, CAT product scope will also be more sensitive to productivity than is regular product scope.

[29]See Mrazova and Neary (2011) for an elegant exposition of this point.

We identify a set of plausible demand and supply-side modeling features that can yield these predictions, and discuss each in turn below. While these extensions are each plausible and straightforward to implement, most of them have not yet been explored in the heterogeneous firms literature. Our work suggests that they deserve more consideration in future research. At the same time, the theory offers additional guidance on how to approach the trade data, and in particular how to make progress in disentangling demand from supply-side explanations empirically, which we leverage in section 8.

Finally, note that there is nothing intrinsically 'international' about the theory we present below. We examine the choice between producing and sourcing from the perspective of how firms best serve markets, and remain silent on whether the sourced products are produced by domestic firms or imported.

7.1 Basic Framework

Consider an otherwise standard framework in which heterogenous multi-product firms face a two-tiered problem: to choose the optimal *product scope* (how many product varieties to sell to the market and at what price and quantity for each) and a *make-or-source* decision (for each variety, whether to produce in-house or source through an arms-length supplier; i.e. via Carry-Along Trade).[30] We refer to goods produced in-house as *regular* or *produced* products and goods sourced from arms-length suppliers as *sourced* or *carry-along* (CAT) products.

Customers. A mass of identical customers has well-behaved preferences over differentiated goods, where goods are product(i)-firm(j) specific. Customers can be consumers or downstream firms (e.g. assemblers) and (crucially) do not differentiate between goods produced in-house by firm j and those sourced by firm j from a supplier. We assume that aggregate demand systems are twice continuously differentiable in relevant arguments and that any demand-side income effects are absorbed in total market quantity Q, which is taken as given by atomistic firms.[31] Let the inverse market demand for a given firm-variety product be given by:

$$p_{ij} \equiv p_j(q_{ij}, Q_j, Q) \ \forall i, j.$$

To maximize generality, we consider this general form of demand, subject to a few key assumptions. Specifically, we assume that demand for any given product ij is symmetric across varieties within

[30] Our approach is intentionally agnostic, designed to identify and evaluate multiple potential sources of CAT in a unified framework. We therefore focus only on equilibrium selection among a set of heterogeneous firms while purposely setting aside derivation of full general equilibrium. Mrazova and Neary (2011) make a compelling argument for this approach. See the online appendix or Bernard et al. (2012) for more formal treatment, including the conditions for existence and uniqueness.

[31] Aggregate quantity is given by $Q \equiv \int_{\omega} q_{ji} d\omega$, where ω is the (endogenous) set of all products sold in the market in the market. Although we treat firms as atomistic within the industry, market power could be incorporated into the model, as in Eckel and Neary (2010), without fundamentally changing the qualitative findings about the production and sourcing of products.

the firm (thus, the definition of 'core' products comes from the supply side, not demand) and is downward sloping in own-quantity, q_{ij}.[32] At the same time, we permit the possibility of both firm-level 'demand-shifters' (via potential differences in the $p_j(\cdot)$ function) and negative intra-firm "cannibalistic" demand spillovers that operate via total firm sales (Q_j), by allowing $\frac{\partial p_{ij}(\cdot)}{\partial Q_j} \leq 0$ (as in, e.g., Eckel and Neary (2010) or Dhingra (2013)).

Firms. A continuum of atomistic firms, indexed by $j \in [0, 1]$, may each provide multiple unique products to the market. Each firm has a 'core' product indexed by $i = 0$; remaining products are indexed by their 'distance' (formalized below) from the core according to $i \in (0, k(j)]$, where $k(j)$ also denotes the (endogenous) set, or scope, of products provided to the market by firm j.

Firms can serve the market by producing goods in-house, by sourcing from arms-length suppliers, or some combination of the two: producing some goods and sourcing others. Let firm j's marginal cost of producing product i in-house be given by $c(j, i)$, which is continuously differentiable in each argument. Then index firms so that low j firms are the most productive, so that for any given product distance from the core, i, the marginal cost of production is (strictly) increasing in j: $\frac{\partial c(j,i)}{\partial j} > 0 \ \forall i$. In-house production exhibits constant returns to scale within each product, but diseconomies of scope across products: $\frac{\partial c(j,i)}{\partial i} > 0 \ \forall j$.[33] To keep things simple, assume that sourcing technology exhibits constant returns in both scale and scope and be given by $\hat{c}(j, i) = \hat{c}(j) \ \forall i, j$.[34]

In addition to the direct (constant) marginal cost of producing or sourcing each good, all firms face a product-specific per-unit distribution cost, $\delta(j, i)$. This distribution cost is constant with respect to quantity within each variety and independent of whether goods are made in-house or sourced from arms-length suppliers. By design $\delta(\cdot)$ has no influence on the pattern of firms' make-or-source decisions. It does, however, increase with a product's distance from the firm's core product (i.e. $\frac{\partial \delta(j,i)}{\partial i} > 0$), which ensures that firms do not expand scope infinitely.[35] At the same time, this distribution cost offers additional potential supply side explanations for CAT, as discussed shortly.

Make-or-Source Decision. For each product i it sells, a given firm j decides whether to produce in-house at constant marginal cost $c(j, i)$, or to source from a supplier at constant marginal cost $\hat{c}(j)$. Since customers and distribution make no distinction between regular and CAT goods, the make-or-source decision for any given product i is simply a choice of the lowest marginal cost means of procurement. Because in-house production exhibits decreasing returns to scope whereas the sourcing technology has constant returns to scope, it follows that every firm will have a unique

[32]Under standard assumptions (quasi-convex preferences), $\frac{\partial p_{ij}(\cdot)}{\partial q_{ij}} \leq 0$. We adopt the stronger assumption that $\frac{dp(\cdot)}{dq_{ij}} < 0$, which also disciplines any potential (positive) demand side spillovers (introduced later).

[33]Our assumption is that the unit cost of production increases for only the *marginal* product as scope expands, as in Eckel and Neary (2010).

[34]The online appendix demonstrates the robustness of the key results under diseconomies of scope in sourcing, which would arise if the cost of reaching additional suppliers increases as a firm sources more products, akin to effects of geography in Bernard et al. (2014a) or the costs of reaching new consumers in Arkolakis (2010).

[35]Specifically, we assume that the diseconomies of scope embedded in $\frac{\partial \delta(j,i)}{\partial i} > 0$ are strong enough that every firm has a finite optimal scope. See the online appendix.

make-or-source threshold that delineates regular, produced goods from sourced (CAT) goods. This threshold, denoted by $\hat{k}(j)$, is independent of total firm scope and is defined implicitly by $c(j,\hat{k}(j)) = \hat{c}(j)$. In equilibrium, each firm j will produce in-house all products $i \leq \hat{k}(j)$ and will source the remaining products $i > \hat{k}(j)$ from arms-length suppliers.[36]

It is immediate that firms with lower costs of in-house production will source less, while higher cost (less productive) firms will source more, all else equal. More generally, the threshold make-or-source margin will be increasing in firm productivity, i.e. $\hat{k}'(j) \leq 0$, as long as firm productivity conveys a greater cost advantage in production than it does (if at all) in sourcing. We return to this point shortly.

The optimal cost function for each firm-product pair may then be written $\tilde{c}(j,i) \equiv \min\{c(j,i), \hat{c}(j)\}$ and is simply the lower envelope of the in-house and CAT-sourced cost curves over the support of products. Notice that this minimized cost function is strictly increasing in i until $i \geq \hat{k}(j)$ and constant thereafter.

Optimal Scope. From here we can define the profit function for any given firm-product pair

$$\tilde{\pi}(j,i) = \max_{q_{ji}} [p_j(q_{ji}, Q_j, Q) - \tilde{c}(j,i) - \delta(j,i)]q_{ji}. \tag{4}$$

Notice two important points: first, the firm-product profit function embodies the optimal make-or-source decision, $\hat{k}(j)$, through $\tilde{c}(\cdot)$; second, more remote varieties are less profitable, $\frac{\partial \tilde{\pi}(j,i)}{\partial i} < 0$, since the marginal cost (inclusive of distribution cost) is strictly increasing in distance from the core and demand is symmetric across varieties within the firm. We summarize the *set* of products sold by a firm as the total *product scope*, $k(j)$, where the firm will sell all products $i \leq k(j)$, and no others.

Aggregating a firm's profit for each variety over the set of all offered products $i \in [0,k]$, firm j's total firm profit as a function of scope and productivity is defined as:

$$\Pi(j,k) \equiv \int_0^k \tilde{\pi}(j,i)di. \tag{5}$$

Taking the derivative with respect to k yields the first order condition that implicitly defines the firm's optimal scope, $k(j)$:[37] [38]

[36] As our focus is on manufacturers, we assume that every firm has an in-house cost advantage in its core product, thus ruling out pure intermediaries.

[37] The second order condition requires that the total profitability adding an additional (k^{th}) product is decreasing as scope rises. In the absence of infra-marginal spillovers, this is ensured by the assumption of strictly increasing distribution costs with product remoteness ($\delta'(i) > 0$) and weakly rising diseconomies of scope in production and sourcing which imply that: $\frac{\partial^2 \Pi(j,k)}{\partial k^2} = \frac{\partial \tilde{\pi}(j,k)}{\partial k} = \frac{\partial \tilde{\pi}(j,i)}{\partial i}\Big|_{i=k} = -q^o_{ji}\Big(\underbrace{\frac{\partial \tilde{c}(j,i)}{\partial i} + \delta'(i)}_{+}\Big)\Big|_{i=k} \leq 0$. More generally, we need to assume that the diseconomies of scope are sufficient to outweigh any potential positive infra-marginal spillovers. We formalize these conditions for existence and uniqueness in the online appendix.

[38] Note that with super-convex preferences (including CES), which imply an infinite choke price, one must incorporate a (potentially very small) fixed cost for adding each new product in order to ensure existence of finite $k(j)$. See the online appendix for formal treatment.

$$\frac{\partial \Pi(j,k)}{\partial k} = \underbrace{\int_0^{k(j)} \frac{\partial \tilde{\pi}(j,i)}{\partial k} di}_{\text{infra-marginal spillovers}} + \underbrace{\tilde{\pi}(j,k(j))}_{\text{marginal variety } \pi} = 0. \tag{6}$$

That is, if increasing firm scope has no effect on the profitability of other varieties in the firm's portfolio, each firm should continue to add products until the profit of the most remote variety is equal to zero. If instead infra-marginal spillovers are negative, for instance because of demand cannibalization as in Dhingra (2013), then the firm should offer fewer varieties in equilibrium. Conversely, if expanding product scope increases the profitability of the firm's other varieties, the firm should add products until the losses from the last variety added are large enough to outweigh the infra-marginal benefit of increasing product scope.

Benchmark Case. To fix ideas, first suppose that demand, sourcing costs, and distribution costs are symmetric across firms and independent across varieties. Since by construction there are no demand or supply side spillovers across varieties within the firm, every firm will continue adding products until the profitability of the marginal variety is zero: $\tilde{\pi}(j,k(j)) = 0$. And since all firms face symmetric demand, distribution, and sourcing costs, it must be true that total equilibrium firm scope will be the same across every firm that engages in any Carry-Along Trade. At the same time, however, regular product scope will be strictly increasing in firm productivity, because, as noted earlier, the make-or-source margin is increasing with firm productivity. Thus, it must necessarily hold that CAT scope is decreasing with firm productivity, contrary to the empirical evidence.[39] A simple symmetric, no spillovers set-up cannot generate predictions consistent with the data. There must therefore be some reason for more productive firms to increase total product scope relative to less productive firms, even when both engage in Carry-Along Trade at the margin.

Broadly, there are two types of explanations for why more productive firms would optimally source more products in equilibrium. It must be the case that either higher productivity firms enjoy greater (positive) infra-marginal spillovers across products, which in turn drive them to expand total product scope more quickly than less productive firms, or, for any given product scope, the profitability of the marginal sourced product is higher for more productive firms. Moreover, the source of complementarity between productivity and sourcing must be sufficiently strong to ensure that the number of sourced products is increasing with productivity. That is, it must be the case that total firm scope is increasing faster than regular product scope in firm productivity. Below, we explore several features of demand and supply that can generate this result.

7.2 Demand Side Explanations

We start by considering potential demand-side explanations for the patterns observed in the data. The first extension maintains the assumption that preferences are symmetric both across products

[39]See the online appendix for formal treatment of the benchmark (symmetric no-spillovers) case.

within a firm and across firms with the same number of products, but introduces a (symmetric) feature of demand called *demand-scope complementarity.* In a second extension, we introduce a second dimension of firm-level heterogeneity via an ex-ante exogenous firm-specific demand component (or 'demand shifter') and show it can also generate predictions consistent with the evidence, but only if core manufacturing productivity and firm-level demand are sufficiently correlated.

Demand-Scope Complementarity

Consider the potential for positive demand-side spillovers via demand complementarity in customer preferences.[40] Specifically, suppose that demand for a given firm-product increases as the firm's total scope of product offerings increases.[41] The idea is that *ceteris paribus* customers prefer to buy products from firms that offer a wider range of products: when a firm expands the set of products it offers to the market, demand for all of its varieties increases. Taking a reduced form approach, we capture demand-scope complementarity via the augmented form of a general demand function: $p_{ij} = p(q_{ij}, k(j), Q)$, where $\frac{\partial p(q_{ij},k(j))}{\partial k} > 0$.[42]

As before, the make-or-source decision will be based only on cost minimization and therefore independent of the total product scope or the extent of demand-side spillovers. Now, however, each firm's optimal (total) product scope, $k(j)$, will depend on the extent of demand complementarity. Because more productive firms will sell larger quantities of each of their regular products *ceteris paribus* ($\partial q^o_{ji}/\partial j < 0$), the positive demand-side spillover from adding an additional product will be greater for higher productivity firms. Higher productivity (lower j) firms will therefore have a higher optimal total product scope than lower productivity firms.

Expanding equation 6 under presence of demand-scope complementarity (and using the envelope condition) yields the implicit solution of a firm's optimal scope $k(j)$:

$$\frac{\partial \Pi(j,k)}{\partial k} = \int_0^k \frac{\partial \tilde{\pi}(j,i)}{\partial k} di + \tilde{\pi}(j,k) = \underbrace{\int_0^{k(j)} \frac{\partial p(q_{ji},k)}{\partial k} q^o_{ji} di}_{\text{demand spillover} \equiv DS(j)} + \tilde{\pi}(j,k(j)) = 0. \tag{7}$$

[40]Other papers that capture demand-side spillovers in the heterogenous firms literature include Feenstra and Ma (2008), Eckel and Neary (2010), Bernard et al. (2010b), Arkolakis et al. (2015), and Dhingra (2013). In each of these papers, either oligopolistic market structure (in the first two papers) or the underlying preferences (e.g. nested CES) generate intra-firm *quantity cannibalization,* a negative spillover where additional sales of one product crowd out sales of other products by the same firm. This negative spillover is larger for more productive firms and therefore works against the sourcing patterns observed in the data. (See the online appendix for formal treatment.) Among these papers, only Dhingra (2013) considers the possibility of positive demand spillovers. Along similar lines, Richards (2006) demonstrates that demand complementarities can justify promotional sales by sumermarkets.

[41]Oxenfeldt (1966) articulates eight consumer behaviors that would generate complementary demand by which "the addition of one more item to a company's offerings leads prospective buyers to value all products in that line more than before..." (p. 143) including a preference for "one-stop shopping," the potential for impulse buying, or sales of quality supplements (in his example, specialized devices to sharpen or adjust cutting tools).

[42]Note that demand scope complementarity is compatible with quantity cannibalistic preferences, $p_{ij} = p(q_{ij}, k(j), Q_j)$, where $p(\cdot)$ is increasing in the second argument and decreasing in the first and third arguments.

Since the positive demand-side spillovers are higher for more productive firms, $DS'(j) < 0\ \forall k$, more productive firms will have a greater equilibrium total product scope, $k'(j) < 0$, even when engaged in Carry-Along Trade at the margin.[43]

With demand-scope complementarity, both regular product scope and total product scope are super-modular with productivity in firm payoffs, which is necessary to match the data, but not yet sufficient. The condition for CAT scope and productivity to be super-modular in firm payoffs, i.e. for equilibrium CAT product scope to rise with firm productivity, is again that total product scope increases *faster* with firm productivity than does regular product scope for all firms engaged in CAT: $k'(j) < \hat{k}'(j) < 0$ for all j s.t. $\hat{k}(j) < k(j)$. Sufficient advantage in core manufacturing productivity or sufficient demand-scope complementarity will generate the result.

Although we interpret demand-scope complementarity as a feature of underlying preferences, note that it is possible to generate similar results for positive demand-scope spillovers as the result of strategic bundling or tie-in exercised by oligopolistic firms. A long literature beginning with Cournot (1838) demonstrates that under certain conditions, a firm with market power can increase demand for some of its (core) products by bundling sales with ancillary products. Profitable bundling strategies can arise whether demand is independent (or negatively correlated) across goods (Stigler, 1963; Adams and Yellen, 1976; McAfee et al., 1989), and also when goods are complementary (Whinston, 1990; Economides and Salop, 1992; Matutes and Regibeau, 1992; Chen, 1997; Denicolo, 2000). Thus, even in the absence of preference-driven demand complementarities, a form of *induced demand-scope complementarity* could arise through endogenous bundling by firms with market power.

Heterogeneous Firm-level Demand

Firm-level heterogeneity in demand offers a second, distinct potential demand-side explanation for Carry-Along Trade. Important work by Foster et al. (2012) suggests that demand-side heterogeneity plays an important role in explaining differences in performance across firms, particularly in the context of revenue-based definitions of productivity.[44] To see how demand heterogeneity would enter our model, suppose that in place of (ex-ante symmetric) demand-scope complementarities, some firms are simply more popular with customers than others and can charge higher prices (and/or sell more) as a result of greater demand. These firm-specific demand shifters *could* generate predictions consistent with the data, but only if core manufacturing productivity and firm-level demand are positively and sufficiently correlated: if the most productive firms are better both at making products in-house and in selling sourced products, then both regular and CAT product

[43] If $\frac{\partial^2 p(q_{ji},k)}{\partial k \partial q_{ij}} = 0$, $DS'(j) = \int_0^k \Big(\underbrace{\frac{\partial p(q_{ji},k)}{\partial k}}_{(+)} \underbrace{\frac{\partial q^o_{ji}}{\partial j}}_{(-)} \Big) di < 0$. From the total derivative of equation 7, $k'(j) = -\frac{DS'(j)}{\partial \tilde{\pi}(j,k)/\partial k} < 0$.

[44] Along a similar vein, recent work by Atalay et al. (2014) suggests that "intangible" firm-level differences, which might include product branding, may play a similar role in explaining firm success across different products.

scope could be increasing in firm productivity. If instead the *only* heterogeneity across firms is on the demand-side, there would be no reason why high-demand firms would necessarily make a greater range of products in-house, as is needed to match the data.[45]

Recent work by Eckel et al. (2015) develops a model in this spirit, linking firm-level manufacturing productivity with firm-level demand. In their model, multi-product firms endogenously invest in firm (brand) "quality", effectively a firm-level demand shifter. The returns to quality innovation increase with (quantity) scale. More productive (lower cost) firms thus invest more in brand quality and therefore offer greater product scope in equilibrium, all else equal.[46] Thus, their model exhibits a form of ex-post *quality-induced demand complementarity*, which has similar equilibrium characteristics to the demand-scope complementarity introduced above.

7.3 Supply Side Explanations

We now consider three plausible supply-side explanations for the patterns found in the data. The first considers the possibility of increasing returns in distribution networks, which would generate positive supply-side spillovers across products and allow more productive firms to leverage economies of scale. Two other explanations consider instead the possibility of multi-dimensional firm heterogeneity on the supply side, allowing more efficient producers to have better access to upstream suppliers or more efficient distribution networks.

Economies of Scale in Distribution

Economies of scale in distribution offer one potential supply-side explanation for the positive relationship between Carry-Along Trade and firm productivity observed in the data. Suppose that the marginal cost of distribution is decreasing in the total output sold by a firm; i.e. $\frac{\partial \delta(i;Q_j)}{\partial Q_j} < 0$. Since more productive firms will produce a greater total quantity of output for any given product scope (because the cost of regular production is lower), they will have an advantage in distribution costs relative to less productive firms, even when sourcing at the margin. In equilibrium, more productive firms will therefore offer a greater scope of products. If these economies of scale in distribution are sufficiently strong, total product scope could increase faster in productivity than regular product scope, so that more productive firms both produce and source more products in equilibrium, as we see in the data.

[45]The rate at which regular product scope increases with productivity ($\hat{k}'(j) < 0$) depends on manufacturing productivity, while the responsiveness of total product scope ($k'(j)$) depends on the firm-level demand shifter.

[46]More precisely, the model of Eckel et al. (2015) allows both firm- and firm-product level quality investment, but it is only the firm-level quality adjustment, $\bar{Z}$ in their model, that affects equilibrium product scope.

Heterogeneous Distribution Technology

A different potential explanation lies in heterogenous (but constant returns to scale) distribution costs, where more efficient producers also have better distribution networks, i.e. $\frac{\partial \delta(j,i)}{\partial j} > 0 \forall i$.[47] Under this possibility, total firm scope will again be increasing with firm productivity ($k'(j) < 0$), since the most efficient producers will face lower distribution costs at the margin, enabling them to expand total product scope relative to less productive firms, even when both are engaged in sourcing at the margin. The relationship between CAT scope and firm productivity will again depend on how rapidly total versus regular product scope expand as firm productivity increases. CAT scope will be increasing with firm productivity if and only if $k'(j) < \hat{k}'(j) < 0$ – or in other words, if firm-level productivity conveys a greater advantage in distribution (increasing total product scope) than it does in production (increasing regular product scope).

Heterogeneous Sourcing Technology

Finally suppose instead that distribution costs are the same across firms, but that the cost sourcing from upstream suppliers varies across firms according to $\hat{c}(j)$. To generate supermodularity between CAT scope and productivity, it is obvious that the firm-level cost of sourcing, $\hat{c}(j)$ must be monotonically (and sufficiently) increasing in j, so that the most productive firms would have access to the lowest cost upstream suppliers.[48] If this condition is satisfied so that more productive firms have access to better sourcing technology, it is immediate that total product scope will be monotonically increasing with firm-level productivity, even for firms engaged in Carry-Along Trade at the margin; i.e. $k'(j) < 0$. This prediction is again necessary but not sufficient for explaining the empirical evidence. When more productive firms can also source more efficiently, there is no guarantee that regular firm scope will still be increasing with firm productivity: more firms might make fewer, not more, products in-house, contrary to empirical evidence.

In fact, the key features exhibited by the data are a special case, or "Goldilocks" result.[49] If a firm's access to superior sourcing technology is too highly correlated with its core in-house productivity, then regular product scope, $\hat{k}(j)$, will be decreasing in firm productivity. Conversely,

[47] This mechanism is consistent with a model in which a firm-level characteristic, e.g. good management, extends to all activities of the firm including production and distribution (and potentially sourcing). Like the firm-level demand shifters explored above, this is consistent with the "intangibles" defines by Atalay et al. (2014). Alternatively, this firm-level advantage might derive from a fixed cost to improving distribution technology – more productive firms then may elect to invest more in "distribution technology" endogenously.

[48] We simply posit the relationship between sourcing technology and underlying firm productivity here, but richer micro-foundations are possible. One possibility consistent with ex-post heterogeneous sourcing technology under incomplete contracts is along the lines of Grossman and Hart (1986). If more productive firms have (endogenously) superior bargaining power with potential upstream suppliers, they will have ex-post lower sourcing costs. We thank Gordon Hanson for pointing out this potential mechanism.

[49] To yield predictions consistent with the evidence, the positive correlation between marginal cost of production and marginal cost of sourcing has to be "just right" and cannot be either too strong or too weak. We refer to this as a "Goldilocks" result after the British and American fairy tale, see http://en.wikipedia.org/wiki/The_Story_of_the_Three_Bears .

if the sourcing technology is insufficiently correlated with in-house productivity, then CAT scope will be negatively related to productivity in equilibrium. Only if the relationship between sourcing technology and firm productivity is "just right", sufficiently correlated but not *too* correlated, is it possible that both regular and CAT product scope will be increasing with firm productivity.

Discussion

In summary, there are several relatively straight-forward demand and supply-side modifications of standard modeling assumptions that can deliver predictions consistent with the data. If offering more varieties to the market increases the demand for all of a firm's products, or if the most productive firms are also the most popular, then the most productive firms will optimally supply more regular and CAT products to the market as we observe. On the supply side, increasing returns to scale in distribution or sufficient correlation between firm-level advantages in production, distribution, and sourcing technology can also explain why more productive firms would offer greater regular product scope, CAT product scope and total product scope in equilibrium. Although each of these demand and supply-side features offers a plausible amendment to the basic model, most have been afforded little if any attention in the existing literature. Our work suggests that these explanations warrant increased attention in future theoretical and empirical work on firm behavior.

Our theoretical exercise also offers additional guidance about how to approach firm-level data on exports and Carry-Along Trade. First, the model suggests a way to conduct a general robustness check of the theory using data on firm-level export values. Every variant of the model rests on the underlying assumption that firms will produce in-house the goods for which they have the greatest productivity advantage and source the remaining, less profitable, products via CAT. If true, the equilibrium total and average value of firm-level exports should be higher for regular products than for CAT products. These measures should also be (weakly) increasing in firm productivity, with the average value of regular exports increasing faster than the average value of CAT exports.[50] These general predictions are readily taken to data, and serve as straightforward falsification exercise tied to the basic make-or-sourcing framework in our model.

Second, the theory offers a way to examine whether CAT is more likely driven by demand or supply-side forces. Although the demand- and supply-side mechanisms we explore have similar implications for the equilibrium relationship between product scope and firm productivity, they have opposing implications for the relationship between firm product scope and export *prices*. All of the demand-side drivers of CAT predict that, all else equal, product scope and average prices should be positively related. Under demand-scope complementarity, an increase in a firm's total

[50] The direct manufacturing advantage of higher productivity firms applies only for regular products, while other firm-level advantages apply to both CAT and regular products. Average sales of regular products should be increasing faster in firm productivity than average sales of CAT products. The obvious exception to this reasoning is that under the heterogeneous sourcing cost explanation, average firm-product exports of sourced goods *could* rise in tandem with regular exports for more productive firms.

product scope causes demand to increase for all of the firm's products. All else equal, for any given firm-variety product, an increase in total firm scope should cause the export price to rise, holding marginal costs and the (own-variety) quantity of sales fixed.[51] Alternatively, under heterogenous firm-level demand, more "popular" firms both sell more products and can charge higher prices in equilibrium. Again, holding costs and quantity fixed, we would expect the export price of any given firm variety to be positively correlated with total firm product scope (although the relationship between product scope and prices is not causal).

Conversely, supply-side explanations for CAT predict a negative relationship between product scope and export prices. If more productive firms have either lower sourcing costs or lower distribution costs (whether by assumption or via increasing returns to scale in distribution), the most productive firms will have the lowest marginal cost of serving the market and (therefore) the highest product scope. For any given quantity of sales, theory thus predicts a negative relationship between the price of a given firm-variety and firm-product scope (again, controlling for equilibrium sales volume). The next section takes these predictions to the data.

8 Back to the Data

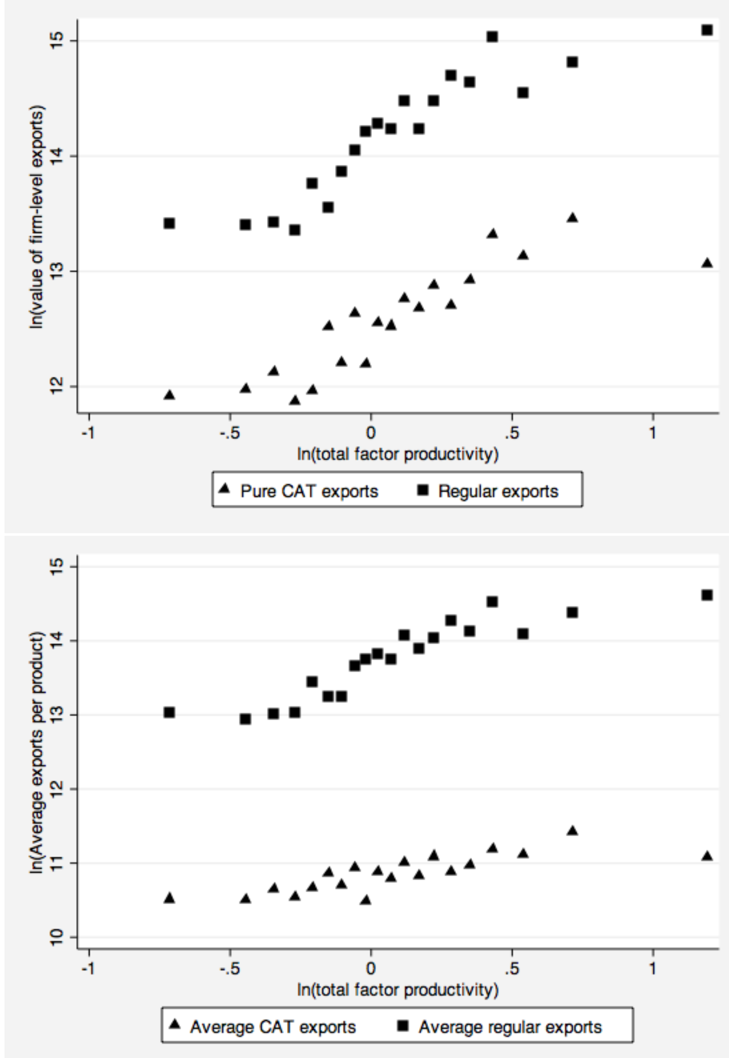
We now return to the data to leverage the additional implications of the theory discussed above. We begin by exploring the theoretical predictions for export values, which are common to both demand and supply-side explanations of CAT. This exercise both serves as a simple falsification exercise and further refines our understanding of firms' production and sourcing margins. The remaining exercises are designed to make headway in disentangling demand- from supply-side drivers of CAT.

Total and Average Export Values

The previous section identifies a set of demand- and supply-side explanations that are each capable of predicting a positive relationship between firm productivity and the numbers of produced and sourced products. As noted above, each of these explanations also carries a set of common predictions for export *values*. First, we expect that firm-level total export value of regular products should always be greater than the total export value of CAT products, for simple reason that firms will produce in-house those (core) goods that they are best at making. And second, because theory predicts that more productive firms will export more regular and CAT products, the *total* firm-level export value of both regular and CAT products should be increasing in firm productivity. Exercising similar logic, we expect that average firm-product exports should be greater for regular products than for CAT products within the firm. In general, the difference between average regular and

[51] Recall the definition of demand-scope complementarity, under which (inverse) demand is given by $p_{ij} = p(q_{ij}, k_j, Q_j, Q)$, where $\frac{\partial p(q_{ji}, k_j, Q_j, Q)}{\partial k_j} > 0$.

Figure 2: Productivity and Total and Average Exports, 2005



CAT exports should also increase as firm productivity rises, under both demand- and supply-side explanations.

The top panel of Figure 2 confirms that firm-level regular exports are larger than CAT exports at all levels of productivity and that both are increasing as firm productivity rises for manufacturing exporters, as expected. Likewise, the bottom panel of Figure 2 offers additional evidence consistent with the model, demonstrating that the average exports are in fact greater for regular products than for CAT products and that the difference increases as firm productivity rises.

It is reassuring that these additional predictions from the theory are confirmed in the data, but they still do not help us understand whether CAT is more likely to come from demand or supply-side drivers.

Co-Production and Co-Exporting:

For an indirect look at the potential drivers of Carry-Along Trade, we examine not the quantities, but the *types* of products that are co-exported by Belgian manufacturing firms. Figure 3 reports three matrices that compare co-production and co-exporting for regular and CAT products by the firms in our data. In the top panel (A), each cell reports the count of firms that produce at least one good in the sector represented by the row and one good in the sector represented by the column. (The sectors correspond to the 20 main chapters in the Prodcom and HS classification systems.) For example, there are 9 firms that produce at least one product in both Chemical Products (VI) *and* in Vegetable Products (II). Cells in the matrix are highlighted if they have more than 12 firms, which is the average count across all the cells in the co-production matrix.

The middle (B) and bottom (C) panels report two different views on co-exporting of products. The middle panel (B) shows the firm counts for co-exporting of regular products, those produced by the firm. Again cells with more than 12 firms are highlighted. The co-exporting matrix for regular products is quite similar to the co-production matrix and is, in fact, not statistically significantly different.[52]

The bottom panel (C) gives the overall co-exporting matrix including both regular and CAT products. Co-exporting across all types of products occurs frequently, with more than 12 firms reporting co-exports in virtually every pair of sectors other than Arms and Ammunitions (IXX). The overall pattern of co-exporting looks very different from the pattern of co-production or co-exporting of regular goods; a chi-squared test confirms that this matrix is statistically different from the other two (at any significance level).[53] For instance, while Transport Equipment (XVII) is co-produced with Machinery and Equipment (XVI) and Base Metals (XV), Transport Equipment is co-exported by large numbers of firms who also export products in Chemicals (VI) and Rubber and Plastics (VII) and also substantial numbers of firms in sectors where there is no co-production, including Raw Hides, Wood Products, and Wood, Pulp and Paper. The pattern of co-exporting across broad ranges of sectors is pervasive and extends far beyond observed production relationships in the Belgian input-output tables.

While not conclusive by any means, we posit that the widespread co-exporting across sectors aligns more closely with the demand-based patterns reported most often by the firms we interviewed. The canonical example of co-exporting among the firms we contacted is the one in which

[52]The statistic for testing whether the entire matrix of co-exporting frequencies is generated by the co-production frequency distribution, is distributed chi-squared, see Bernard et al. (2010b). We test the null that two matrices are the same using ψ-squared statistic with 209 degrees of freedom. The test statistic for the co-production and co-exporting of regular products is 104.73 which cannot reject the null hypothesis of equality at any level of significance (p value= 1.00).

[53]The chi-squared statistics for testing the equality of the co-exporting matrix for all products against the co-production matrix or the co-exporting matrix for regular products are 3352 and 2863 respectively, both significant at any level.

Figure 3: Co-production and Co-exporting

Panel A: Co-production

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	IXX	XX
I	Live animals, animal products	70																			
II	Vegetable products	4	25																		
III	Animal or vegetable fats/oils	9	4	12																	
IV	Prepared foodstuffs	67	41	18	218																
V	Mineral products	2	1	1	3	12															
VI	Chemical products	8	9	13	29	24	152														
VII	Rubber and plastics (articles)	2	3	2	8	14	60	159													
VIII	Raw hides and skin (articles)	4	0	1	0	0	1	5	6												
IX	Wood and derived products	0	0	0	0	1	2	7	1	61											
X	Wood pulp, paper, cardboard	1	1	1	3	1	7	27	4	3	115										
XI	Textiles (articles)	0	0	0	1	1	9	32	7	1	11	180									
XII	Foodwear, headgear	0	0	0	0	0	2	4	2	1	2	8	3								
XIII	Stone, cement or plaster	0	0	0	0	2	13	16	1	3	3	7	1	48							
XIV	Precious metals	0	0	0	0	0	2	1	1	1	1	1	1	1	2						
XV	Base metals (articles)	0	1	0	1	6	18	47	2	6	10	13	2	8	2	140					
XVI	Machinery and equiment	0	0	1	1	0	6	26	1	1	13	6	0	3	0	71	220				
XVII	Transport equipment	0	0	0	0	1	2	11	0	0	0	4	1	2	0	18	26	41			
XVIII	Optical, precision instruments	0	0	0	0	0	3	6	0	1	0	0	1	2	0	5	18	3	17		
IXX	Arms and amunitions	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	1	
XX	Miscellaneous	0	0	0	0	1	4	27	3	23	3	11	3	7	1	29	13	7	2	0	124

Panel B: Co-exporting (produced products)

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	IXX	XX
I	Live animals, animal products	48																			
II	Vegetable products	1	18																		
III	Animal or vegetable fats/oils	4	3	8																	
IV	Prepared foodstuffs	43	21	13	152																
V	Mineral products	0	1	1	3	8															
VI	Chemical products	4	4	10	17	12	113														
VII	Rubber and plastics (articles)	0	2	1	4	4	40	86													
VIII	Raw hides and skin (articles)	0	0	0	0	0	0	3	2												
IX	Wood and derived products	0	0	0	0	0	0	3	0	30											
X	Wood pulp, paper, cardboard	1	1	1	3	0	4	16	3	1	58										
XI	Textiles (articles)	0	0	0	0	0	2	13	2	0	6	107									
XII	Foodwear, headgear	0	0	0	0	0	0	2	1	0	1	2	1								
XIII	Stone, cement or plaster	0	0	0	0	1	5	6	0	0	0	2	0	25							
XIV	Precious metals	0	0	0	0	0	1	0	0	0	0	0	0	0	2						
XV	Base metals (articles)	0	0	0	0	3	5	22	0	2	4	4	1	2	1	65					
XVI	Machinery and equiment	0	0	0	0	0	3	11	0	0	5	0	0	0	0	24	96				
XVII	Transport equipment	0	0	0	0	1	0	3	0	0	0	1	1	0	0	7	6	21			
XVIII	Optical, precision instruments	0	0	0	0	0	0	3	0	1	0	0	1	0	0	3	6	1	10		
IXX	Arms and amunitions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
XX	Miscellaneous	0	0	0	0	0	1	9	1	7	0	2	0	2	0	10	2	3	2	0	68

Panel C: Co-exporting (all products)

		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	IXX	XX
I	Live animals, animal products	101																			
II	Vegetable products	39	65																		
III	Animal or vegetable fats/oils	26	22	34																	
IV	Prepared foodstuffs	120	104	56	330																
V	Mineral products	18	23	24	49	93															
VI	Chemical products	49	51	79	153	160	490														
VII	Rubber and plastics (articles)	66	67	67	197	142	579	762													
VIII	Raw hides and skin (articles)	7	6	9	19	11	63	94	45												
IX	Wood and derived products	26	44	26	99	76	235	346	50	170											
X	Wood pulp, paper, cardboard	56	59	55	186	93	381	559	73	262	552										
XI	Textiles (articles)	22	25	27	74	76	258	416	92	173	322	467									
XII	Foodwear, headgear	8	8	6	29	18	55	75	36	47	70	80	34								
XIII	Stone, cement or plaster	22	22	18	66	84	222	289	44	159	186	162	46	208							
XIV	Precious metals	2	1	1	6	7	19	28	14	11	26	20	10	17	11						
XV	Base metals (articles)	36	36	39	116	101	436	685	78	298	431	328	72	303	30	716					
XVI	Machinery and equiment	57	51	52	166	125	519	776	78	293	530	381	63	279	27	767	934				
XVII	Transport equipment	4	3	7	15	17	100	167	21	60	78	71	21	59	5	192	218	129			
XVIII	Optical, precision instruments	13	14	18	41	52	206	265	50	112	197	137	41	123	20	266	338	83	210		
IXX	Arms and amunitions	0	0	0	1	0	3	3	2	0	3	2	1	2	0	4	4	1	3	1	
XX	Miscellaneous	23	21	25	64	47	215	341	79	176	239	232	58	139	16	327	314	67	132	3	261

Note: Each cell reports the count of firms that are active in both HS2 sectors (chapters). The top panel reports counts of firms that produce at least one product in both chapters; the middle panel reports the count of firms that export at least one produced product in both chapters; and the bottom panel reports the count of firms that export at least one product (produced or sourced) in both chapters.

coffee is exported together with coffee machines, plastic utensils and other food products, rather than instance in which frozen foods are sourced and exported because of an expertise in distribution technology. It is difficult to imagine a sourcing or distribution technology that gives rise to co-exporting of products in the Textiles sector and in Stone, Cement or Plaster. Demand side explanations offer greater flexibility in their potential to explain what we observe For instance, a flooring company may export its own manufactured tile together with a selection of sourced rugs.

Export Prices and Export Scope

In the next set of empirical exercises, we leverage two more theoretical predictions in an effort to uncover the underlying reasons for CAT. First, all else equal, demand-side drivers of CAT should imply a positive relationship between firms' product scope and export prices (since greater product scope signals higher demand), while supply-side drivers should lead to a negative relationship (since greater product scope is the result of lower sourcing or distribution costs). Second, if more productive firms have lower sourcing or distribution costs, then the price of (non-produced) CAT exports should be decreasing in firm productivity. Conversely, if demand-side explanations are behind CAT, we would expect a positive relationship between firm productivity and the price of exported CAT products. We explore these sign predictions in the two regressions that follow.

First, by exploiting variation across destinations, we can estimate the relationship between prices and product scope within a given firm-product. If demand-scope complementarities are responsible for Carry-Along Trade, as many of the case study and the company interviews suggest, then, ceteris paribus, we expect to find that export prices for the same product sent by the same firm will be increasing in the number of products sent to a given destination country. Demand heterogeneity could also predict a positive relationship between prices and product scope, but this would influence our estimates within firm-product *only* if the demand shifters are also destination-specific (otherwise they will be captured by the firm-product fixed effect).[54] If instead, supply-side factors are responsible for Carry-Along Trade, we would expect the opposite to hold: within a given firm-product, greater scope would reflect lower sourcing or distribution costs, which should lead to lower prices.

We use the firm-product-country trade data for 2005 to test this simple prediction. Specifically, we estimate a regression of the form:

$$lnP_{fpc} \quad = \quad \beta Scope_{fc} + \gamma Rank(Q_{fpc}) + \theta \tau_{pc} + d_c + d_{fp} + \varepsilon_{fpc,} \tag{8}$$

where lnP_{fpc} is the log of the export price by firm f in product p to country c, $Scope_{fc}$ is the range of products exported by the firm to the destination country (in logs or levels), $Rank(Q_{fpc})$ is a

[54]That is, firm-product fixed effects will capture any "global" demand shifters (e.g. branding) that increase both product scope and prices worldwide; our regressions capture only the variation in product scope across destinations.

control for the firm's relative export quantity sales rank in the product-country market, τ_{pc} is the level of the tariff on product p in country c,[55] and d_c and d_{fp} are country and firm-product fixed effects (additional specifications include product-country fixed effects, d_{pc}).[56] If CAT is driven by demand-side explanations, β should be positive. If instead CAT is driven by supply-side efficiencies in sourcing or distribution, we would expect β to be negative.

An obvious difficulty with the specification in equation 8 is that any firm-country demand shifter, including country-level variation in the taste for the firm's brand, will be correlated with both the price in the destination and the number of products supplied to the market. To mitigate this problem, we instrument for the number of products supplied by a firm to an individual country with a measure of firm-destination average tariffs,

$$avg\,\tau_{fc} = \frac{1}{N} \sum_{p \in \Omega(f)} \tau_{fpc}$$

where $\Omega(f)$ is the entire set of possible products that could be exported by the firm, including all products produced by the firm in Belgium or exported by the firm to any destination. Higher average tariffs for a firm's portfolio of offerings should reduce the number of products shipped to any given market. Controlling for the own tariff, τ_{fpc}, which is included in the second stage regression, any residual relationship between a firm's market access to a given destination and the prices it can charge is capturing the effects of intra-firm spillovers.

Because these regressions depend on variation in tariffs across destination markets, our sample only includes exports outside the European Union. We also construct the dependent variable only for product categories that are represented by a single HS6 code to avoid problems in calculating prices for HS6+ bundles.[57]

Table 7 reports OLS and IV regression results for specifications with $Scope_{fc}$ measured by either the log or the level of the number of exported products. In all cases product scope takes a positive and significant sign, consistent with the presence of demand-side drivers of CAT, including the possibility of demand-scope complementarities. Across destinations, the price of a product exported by the firm is systematically *higher* when the firms ships a greater number of total products. This result stands in direct contrast to to the supply-side explanations of CAT, which, all else equal, would predict that increased product scope would correspond to *lower* prices.

While the instrumental variables design mitigates the possibility that our results are driven by firm-level demand shifters, it cannot distinguish between a narrow definition of demand-scope

[55] Potential differences in bilateral *input* tariffs will be captured by our firm-product fixed effects, since the cost of imported intermediates (from any source country) affects the Begian manufacturer's cost of production for all destinations.

[56] The variable $RankQ_{fpc}$ sidesteps potential concerns over non-classical measurement error while allowing us to control for sales quantity. With differentiated products and downward sloping demand, higher sales quantity will be associated with lower prices, all else equal. In a robustness test, we include product-country fixed effects and drop the quantity variable completely.

[57] The number of exported products includes both HS6 and HS6+ products.

complementarity versus other demand-side spillovers that work through total firm presence in (and market access to) a given destination market.[58] Thus, Table 7 offers evidence of the presence of positive demand-side spillovers, including but not limited to a strict causal interpretation of demand-scope complementarity.

CAT Export Prices and Firm Productivity

In a final exercise suggested by theory, we examine the relationship between firm productivity and the export prices of CAT products.[59] If firm productivity is positively related to efficiency in either sourcing or distribution, then we would expect high productivity firms to have relatively low prices of CAT products. If, however, CAT is driven by demand-side factors such as demand scope complementarity or firm-level demand-shifters like brand equity, we would expect more productive firms to have higher prices for exported CAT products.

To check this relationship, we estimate a regression of the form:

$$ln\widehat{P}_{fpc} \;\; = \;\; \beta lnTFP_f + \varepsilon_{fpc}, \tag{9}$$

where $ln\widehat{P}_{fpc}$ is the *difference* of log of the export price of firm f in CAT product p in country c from the log of the average price of CAT product p in country c and $lnTFP_f$ is the log of productivity of the firm.

Table 8 reports the results for specifications with and without country-product fixed effects, where we have clustered standard errors both by firm and by product-country market. In both cases there is a positive but insignificant relationship between firm productivity and the relative export price of the CAT product by the firm. These estimates hint that more productive firms may charge higher prices for CAT products than do less productive firms, consistent with a demand side mechanism, but the statistical relationship is weak.

Taken together, the case study and company interviews, the descriptive evidence from the co-exporting matrix, and these two sets of regression results suggest that demand-side drivers, and in particular, demand-scope complementarity are likely sources of the CAT phenomenon.

[58] Another possibility is that greater firm sales to a given destination increase overall brand recognition or returns to scale in marketing, or that there are positive cross-price elasticities in demand. These alternative demand-side spillovers are in line with the "induced demand scope complementarities" discussed in section 7.2. Alternatively, market power or strategic bundling by oligopolistic firms could drive the results. If more productive firms also have destination-specific market power and if market power increases optimal product scope and if reduced tariffs afford greater market power, then both product scope and prices may increase in tandem with market access. While it is entirely plausible that more productive firms have more market power (Eckel and Neary (2010)), the limited evidence to date on the effects of tariff liberalization suggest either a pro-competitive effect (De Loecker et al. (2016)) or an increase in market power associated with reduced product scope (Bernard and Dhingra (2015)).

[59] Focusing on CAT products rather than regular products allows us to side-step well-known difficulties when evaluating the effect of productivity on prices apart from marginal cost of production.

9 The Importance of CAT

So far, this paper has demonstrated that Carry-Along Trade is widespread, quantitatively large, and likely driven in large part by demand-side spillovers across products within the firm. In this section, we discuss what these new findings mean for our understanding of firms and policy in international trade. We posit that CAT is about much more than simply "relabeling" sales by manufacturing firms that do not produce everything that they sell. CAT changes how we should think about firms' core competencies and which firms are involved in international trade (and thus subject to trade shocks).

Core competencies and spillovers in multiproduct firms

CAT yields new insight on the underlying drivers of firm performance. As our model makes clear, CAT is not just another margin of firm activity that allows more productive manufacturers to leverage lower costs of production. The theory in Section 7 shows that in order to rationalize the patterns seen in the data, there must be positive intra-firm spillovers across products or multi-dimensional characteristics of firm heterogeneity that are correlated with manufacturing productivity in just the right way. In both company interviews and in Section 8, we find evidence pointing to demand-side spillovers in particular.

These findings are consistent with recent work by Foster et al. (2012), Atalay et al. (2014), and De Loecker et al. (2016) who emphasize the importance of firm-level "intangibles" and demand heterogeneity in explaining differences in firm performance. Our investigation of the CAT phenomenon reinforces the importance of opening the "black box" of firm characteristics, while highlighting potential measurement pitfalls in the presence of widespread sourcing of final goods for Carry-Along sales.

Which firms trade the most

CAT also offers a new twist on the current understanding of which firms are most engaged in global trade. It is well known that trade flows are dominated by the largest and most productive firms (e.g. Bernard et al. (2007)). While our findings are consistent with the existing evidence, they offer a new take on convention by demonstrating that the largest manufacturing firms are acting in part as trade conduits. By extension, this observation points to the existence of a large pool of "shadow suppliers" that produce the goods we observe as CAT exports.

From here, we can draw two inferences. First, the market concentration of manufacturing trade may be lower than initially thought. Second, there may be a significant and as-yet unacknowledged margin of firms – those suppliers of CAT products – that are exporters in all but name. Although our data do not allow us to identify these CAT suppliers, it seems plausible that at least some of them are the small and medium enterprises (SMEs) so often targeted for trade promotion by policy makers.[60] If so, then SMEs may already be considerably more important in shaping global trade than they are currently given credit for. By the same logic, efforts to promote large and productive manufacturers may "trickle up" to SME suppliers via CAT. Moreover, since these CAT-supplier relationships need not operate through vertical supply chain linkages, they may be overlooked in existing studies of SME engagement in Global Value Chains.

The relationship between CAT exporters and their suppliers matters not just for our (static) understanding firms' participation in the global economy, but also for how we measure and model the drivers of trade growth and the transmission of trade shocks. The first point is obvious: in a world with CAT, the performance of manufacturing exporters may hinge on access to low-cost, high quality sourced products to enhance the profitability of "regular" manufacturing products sold by the firm.[61]

At the same time, CAT may amplify the domestic transmission of trade shocks. As illustration, consider a generic across-the board shock, x, which could represent for instance a reduction of foreign market access (higher foreign tariffs), an exogenous reduction in foreign demand, or an increase in distribution costs. Using Q_j to denote total firm sales,[62] and applying Leibniz' rule, we find that the change in export sales for a firm engaged in CAT has three components: the intensive-margin reduction in regular sales, the intensive-margin reduction in CAT sales, and the extensive-margin reduction in total firm scope:[63]

$$\frac{d}{dx}\ Q_j(x) = \underbrace{\int_0^{\hat{k}_j(x)} \frac{dq_j^{REG}(i;x)}{dx} di}_{regular\ \ intensive-margin} + \underbrace{\int_{\hat{k}_j(x)}^{k_j(x)} \frac{dq_j^{CAT}(i;x)}{dx} di}_{CAT\ \ intensive-margin} + \underbrace{q_j^{CAT}(k_j;x)k_j'(x)}_{extensive-margin}. \tag{10}$$

For manufacturing exporters engaged in Carry-Along Trade, a negative trade shock would cause the output of regular products to fall, both through the direct effect of the trade shock and possibly though an indirect effect if, via intra-firm spillovers, lower total firm scope also depresses the optimal sales quantity for regular products.[64] At the same time, however, part of the intensive margin and *all* of the extensive margin adjustment operates through CAT – not regular – product scope. The CAT manufacturer thus can pass along both the extensive margin and part of the intensive-margin adjustments to its suppliers of CAT products.

The implications of CAT for understanding firm-level effects of trade shocks follow directly. If

[60] See for instance: OECD and Bank (2015).

[61] In our model with spillovers, $\frac{\partial \pi^{REG}(j,i)}{\partial \hat{c}} > 0 \forall j, i \leq \hat{k}(j)$.

[62] $Q_j(x) \equiv \int_0^{\hat{k}_j(x)} q_j^{REG}(i;x)di + \int_{\hat{k}_j(x)}^{k_j(x)} q_j^{CAT}(i;x)di$

[63] As we show in the online appendix, there would be an additional extensive margin effect if the shock affects the make-or source margin ($\hat{k(j)}$). In our benchmark model, the make-or-source margin is independent of demand, distribution, or market access costs. More generally it is possible that this additional margin would be affected in the presence of sourcing-specific shock or diseconomies of scope in sourcing.

[64] The specific form of these intensive and extensive margin responses depends, of course, on the underlying driver(s) of CAT.

we were to evaluate the effect of the trade shock in terms of total *sales* by firm j, we would capture all three margins of adjustment. Measured instead in employment terms, however, the effect of the trade shock on firm j would be reflected only the intensive-margin reduction for regular products, which could be far smaller. For the manufacturing exporter, CAT introduces a wedge between the sales-effects and employment-effects of trade shocks. Following a shock, CAT exporters may seem to "weather the storm" with minimal labor dislocations when in fact, the labor market effects have simply been passed along to the CAT suppliers. (Conversely, following a positive trade shock, we would observe an increase in the CAT firms' sales relative to their employment, which could be mistaken for an increase in productivity if the practice of CAT is not take into account.) The potential for mis-measurement of trade shocks or misattribution may be even more important for suppliers of CAT products, which may not immediately associated with trade and, especially if SMEs, may be less visible in national statistics.

More generally, the widespread practice of CAT emphasizes the importance of exercising care in firm-level analysis. Some of the firms most affected by trade may initially appear to be removed from global markets, while those firms most visibly active in global commerce may (at least in employment terms) be more insulated from trade shocks than casual observation would suggest.

10 Conclusion

This paper explores the concept of Carry-Along Trade (CAT), the observed phenomenon in which firms sell more products to the market than they actually produce, in effect "carrying along" products from unaffiliated producers to a destination market. Matching trade and production data for a large sample of Belgian manufacturing firms, we show that Carry-Along Trade is pervasive across firms and products and accounts for a substantial share of exports. CAT makes up at least 10 percent of total firm exports for more than 60 percent of the firms in our sample, and more than 90 percent of manufacturing exporters ship at least one product that they do not make. Together, CAT products represent 30 percent of export value.

Across firms, we find that Carry-Along Trade plays an important role in shaping the relationship between firms' exports and productivity. Previous work on the extensive margins of trade has found that more productive firms export more products. Our findings suggest that this correlation is largely due to the presence of CAT: the number of exported CAT products is strongly increasing in firm productivity while the number of exported produced products is weakly increasing in firm productivity.

To explain these empirical regularities, we develop a model of heterogeneous, multi-product producers and sourcing and demonstrate that either demand or supply-side spillovers or economies of scope are necessary to rationalize the data. On the demand side, we consider firm-level demand shifters and introduce demand-scope complementarity: the notion that demand for a firm's products is increasing in the number of products delivered to the market. Allowing for sourcing or distribution costs that are positively correlated with production costs can match the stylized facts on the number of exported products under certain conditions, as can economies of scale in distribution. Using firm-product export price data across countries, we find empirical evidence in favor of demand-side drivers of CAT. Company interviews and the patterns of co-exporting behavior offer support for the presence of demand-scope complementarities in particular.

There are several directions for future research. Our findings call into question basic assumptions about the nature of the manufacturing firm and the products they produce and sell; a richer set of models of multi-product firms with sourcing thus may prove instrumental for understanding domestic and global supply chains, how they evolve, and how they respond to policy changes. The potential importance of demand-side spillovers, and particularly demand-scope complementarities, in shaping firms' export behavior also raises important theoretical and policy questions. How do demand-scope complementarities change models of firm behavior in general equilibrium? How do we define market access if firms view the relevant unit of sale as a bundle of products, but tariffs are levied on a product-by-product basis? To what extent does access to local suppliers shape firms' success, and how does this relationship depend on import barriers?

While our focus has been on the prevalence and importance of CAT in the cross-section of manufacturing exporters, work is needed to understand how firms develop their portfolio of products delivered to each market, both produced and sourced, and how these products respond to shocks to profitability. Negative shocks to foreign demand may be absorbed largely through reduced exports of CAT products thus passing those shocks through to smaller, apparently domestic producers.

In addition, the presence of sourced products adds yet another complication to the emerging literature on estimating productivity in multi-product firms. A major avenue for future empirical work is the identification and analysis of the upstream producers (domestic or foreign) of the CAT products. Empirical research on trade between firms inside countries is just beginning, e.g. Atalay et al. (2014), but we know of no comprehensive dataset that matches domestic suppliers of sourced products and the sales of those products at downstream firms. The development of data that links firms throughout the supply chain is of fundamental importance.

References

Abreha, Kaleb Girma, Valerie Smeets, and Frederic Warzynski, "Coping with the Crisis: Recent Evolution in Danish Firms' International Trade Involvement, 2000-2010," Technical Report, University of Aarhus 2013. 5

Acemoglu, Daron, Vasco M. Carvalho, Asuman Ozdaglar, and Alireza Tahbaz-Salehi, "The Network Origins of Aggregate Fluctuations," *Econometrica*, 2012, *80(5) September*, 1977–2016. 7

Adams, William and Janet Yellen, "Commodity Bundling and the Burden of Monopoly," *Quarterly Journal of Economics*, August 1976, *90* (3), 475–498. 1, 7.2

Ahn, J., Amit K. Khandelwal, and Shangjin Wei, "The role of intermediaries in facilitating trade," *Journal of International Economics*, 2011, *84(1)* (15706), 73–85. 1, 11, 7

Akerman, Anders, "Wholesalers and Economies of Scope in International Trade," *Canadian Journal of Economics*, forthcoming. 1, 11, 7

Antràs, Pol, Teresa C Fort, and Felix Tintelnot, "The Margins of Global Sourcing: Theory and Evidence from U.S. Firms," *American Economic Review*, forthcoming, (20772). 1

Arkolakis, Costas, "Market Access Costs and the New Consumers Margin in International Trade," *Journal of Political Economy*, 2010, *118* (6), 1151–1199. 34

_ , Sharat Ganapati, and Marc Muendler, "The Extensive Margin of Exporting Goods: A Firm-level Analysis," *Working Paper*, 2015. 1, 4, 1, 40

Arnarson, Bjorn Thor, "The Superstar and the Followers: Intra-Firm Product Complementarity in International Trade," Technical Report, University of Lund 2016. 5

Atalay, Enghin, Ali Hortascu, and Chad Syverson, "Vertical Integration and Input Flows," *American Economic Review*, 2014. 1, 44, 47, 9, 10

Bernard, Andrew B. and Swati Dhingra, "Contracting and the Division of the Gains from Trade," Working Paper 21691, NBER October 2015. 58

_ , Andreas Moxnes, and Yukiko Saito, "Production Networks, Geography and Firm Performance," 2014. 1, 34

_ , Emily J. Blanchard, Ilke Van Beveren, and Hylke Y. Vandenbussche, "Carry-Along Trade," Technical Report, NBER Working Paper No. 18246 2012. 30

_ , **Ilke Van Beveren, and Hylke Vandenbussche**, "Multi-product Exporters and the Margins of Trade," *Japanese Economic Review*, 2014, *65(2)*, 142–157. 2

_ , **J. Bradford Jensen, and Peter K. Schott**, "Importers, Exporters, and Multinationals: A Portrait of Firms in the U.S. that Trade Goods," in T. Dunne, J.B. Jensen, and M. Roberts, eds., *Producer dynamics: New Evidence from Micro Data*, University of Chicago Press, 2009. 1

_ , _ , **Stephen J. Redding, and Peter K. Schott**, "Firms in International Trade," *Journal of Economic Perspectives*, Summer 2007, *21* (3), 105–130. 1, 9

_ , _ , _ , **and** _ , "Wholesalers and Retailers in US Trade," *American Economic Review*, May 2010, *100* (2), 408–13. 1, 11

_ , **Marco Grazzi, and Chiara Tomasi**, "Intermediaries in International Trade: Products and Destinations," *Review of Economics and Statistics*, October 2015, *97* (4), 916–920. 1, 11

_ , **Stephen J. Redding, and Peter K. Schott**, "Products and Productivity," *Scandinavian Journal of Economics*, 2009, *111(4)*, 681–709. 27

_ , _ , **and** _ , "Multiple-Product Firms and Product Switching," *American Economic Review*, March 2010, *100* (1), 70–97. 40, 52

_ , _ , **and** _ , "Multiproduct Firms and Trade Liberalization," *The Quarterly Journal of Economics*, 2011, *126* (3), 1271–1318. 1, 4, 1, 6, 6

Beveren, Ilke Van, Andrew B. Bernard, and Hylke Vandenbussche, "Concording EU Trade and Production Data over Time," Technical Report, NBER Working Paper 18604 2012. 10, A.5

BvDEP, *Belfirst Database*, Bureau Van Dijk Electronic Publishing, 2006. 19

Caves, Douglas W., Laurits R. Christensen, and W. Erwin Diewert, "The Economic Theory of Index Numbrs and the Measurement of Input, Output,and Productivity," *Econometrica*, 1982, *50(6)*, 1393–1414. 15

Chen, Yongmin, "Equilibrium Product Bundling," *Journal of Business*, 1997, *70* (1), 85–103. 7.2

Cournot, A, *Researches Into the Mathematical Principles of the Theory of Wealth*, New York, NY: Macmillan (Translated by Nathanial Bacon from french original (1838)), 1927.

Denicolo, Vincenzo, "Compatability and Bundling with Generalist and Specialist Firms," *Journal of Industrial Economic*, June 2000, *XLVIII* (2), 177–187. 7.2

Dhingra, Swati, "Trading Away Wide Brands for Cheap Brands," *American Economic Review*, February 2013, *103(6)*, 2554–2584. 7.1, 7.1, 40

Eckel, Carsten and Peter Neary, "Multi-product firms and flexible manufacturing in the global economy," *Review of Economic Studies*, 2010, *77* (1), 188–217. 1, 1, 31, 7.1, 33, 40, 58

_ **, Leonardo Iacovone, Beata Javorcik, and J. Peter Neary**, "Multi-product firms at home and away: Cost-versus quality-based competence," *Journal of International Economics*, 2015, *95* (2), 216–232. 7.2, 46

Economides, Nicholas and Steven Salop, "Competition and Integration Among Complements, and Network Market Structure," *Journal of Industrial Economics*, March 1992, *XL* (1), 105 – 123. 7.2

Eurostat, *Prodcom: Statistics on the production of manufactured goods*, Luxembourg: Eurostat, 2006. A.4

Feenstra, Robert C. and Hong Ma, "Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition," in Elhanan Helpman, Dalia Marin, and Thierry Verdier, eds., *The Organization of Firms in a Global Economy*, Harvard University, 2008, chapter Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition. 40

Foster, Lucia, John Haltiwanger, and Chad Syverson, "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?," *American Economic Review*, 2008, *98* (1), 394–425. 27

_ **,** _ **, and** _ , "The Slow Growth of New Plants: Learning about Demand?," Technical Report 17853, NBER February 2012. 1, 7.2, 9

Gabaix, Xavier, "The Granular Origins of Aggregate Fluctuations," *Econometrica*, 2011, *79*, 733–772. 7

Grossman, Sanford J. and Oliver D. Hart, "The Costs and Benefits of Ownership: A Theory of Vertical Integration and Lateral Integration," *Journal of Political Economy*, 1986, *94(4)*, 691–719. 48

Iacovone, Leonardo and Beata Javorcik, "Multi-product Exporters: Product Churning, Uncertainty and Export Discoveries," *Economic Journal*, 2010, *120(544).* 12

Loecker, Jan De, "Product differentiation, multi-product firms and estimating the impact of trade liberalization on productivity," *Econometrica*, 2011, *79(5)*, 1407–1451. 27

_ **, Pinelopi K. Goldberg, Amit K. Khandelwal, and Nina Pavcnik**, "Prices, Markups and Trade Reform," *Econometrica*, 2016. 1, 58, 9

Magerman, Glenn, Karolien De Bruyne, Emmanuel Dhyne, and Jan Van Hove, "Heterogeneous Firms and the Micro Origins of Aggregate Fluctuations," Technical Report, KU Leuven 2016. 7

Matutes, Carmen and Pierre Regibeau, "Compatability and Bundling of Complementary Goods in a Duopoly," *Journal of Industrial Economics*, March 1992, *40* (1), 37–54. 7.2

Mayer, Thierry and Gianmarco Ottaviano, "The Happy Few: The Internationalisation of European Firms," *Intereconomics: Review of European Economic Policy*, May 2008, *43* (3), 135–148. 1, 1

_ **, Marc J. Melitz, and Gianmarco I.P. Ottaviano**, "Market Size, Competition, and the Product Mix of Exporters," *American Economic Review*, April 2014, *104(2)* (16959). 1, 4, 1

McAfee, R. Preston, John McMillan, and Michael Whinston, "Mutliproduct Monopoly, Commodity Bundling, and Correlation of Values," *Quarterly Journal of Economics*, May 1989, *104* (2), 371–383. 1, 7.2

Mrazova, M. and J. P. Neary, "Selection effects with heterogeneous firms," Technical Report, Discussion paper 2011. 29, 30

Nino, Virginia Di, "The phenomenal CAT: firms clawing the goods of others," Technical Report 281, Bank of Italy 2015. 5

OECD and World Bank, "Inclusive global value chains: policy options in trade and complementary areas for GVC integration by small and medium enterprises and low-income developing countries," Technical Report, World Bank Group, Washington DC 2015. 60

Oxenfeldt, Alfred, "Product Line Pricing," *Harvard Business Review*, July-August 1966, pp. 137–144. 6, 41

Petropoulou, Dimitra, "Information costs, networks and intermediation in international trade," Globalization and Monetary Policy Institute Working Paper 76, Federal Reserve Bank of Dallas 2011. 7

Rauch, James E., "Business and Social netowrks in International Trade," *Journal of Economic Literature*, June 2001, *39* (1), 1177–1203. 7

_ **and Joel Watson**, "Network Intermediaries in International Trade," *Journal of Economics & Management Strategy*, 2004, *13* (1), 69–93. 7

Richards, Timothy J., "Sales by Multi-Product Retailers," *Managerial and Decision Economics*, 2006, *27*, 261–277. 40

Stigler, George, "United States vs. Loew's Inc.: A note on Block-Booking," *The Supreme Court Review*, 1963, pp. 152–157. 1, 7.2

Whinston, Michael, "Tying, Foreclosure, and Exclusion," *American Economic Review*, September 1990, *80* (4), 837–859. 1, 7.2

A Data Appendix

The data set used in this paper combines data from four different databases, made available by the National Bank of Belgium: (i) Business Registry, (ii) Foreign Direct Investment Survey, (iii) Trade Database and (iv) Prodcom Database.

A.1 Business Registry

The Business Registry covers the population of firms required to file their (unconsolidated) accounts with the National Bank of Belgium. The data combine annual accounts figures with data from the Crossroads bank on firms' main sector of activity. Overall, most firms that are registered in Belgium (i.e. exist as a separate legal entity) and have limited liability are required to file annual accounts. Specifically, all limited-liability firms that are incorporated in Belgium have to report unconsolidated accounts involving balance sheet items and income statements. Belgian firms that are part of a group additionally have to submit consolidated accounts where they report the joint group's activities in a consolidated way. However, Belgian affiliates that belong to a foreign group and that do not exist as a separate legal entity in Belgium are not required to report unconsolidated accounts (they are required to file a consolidated account, but these data do not allow us to obtain firm-level characteristics specifically for the Belgian affiliate). This implies that whenever these firms are exporters, they will be included in the analysis when using the full export sample, but cannot be included in the sample when we combine the trade data with firm characteristics or when we introduce a sample selection based on firms' main sector of activity (since this information is recorded in the Business Registry database).

There are two types of annual accounts: full and abbreviated. Firms have to file a full annual account when they exceed at least two of the following three cutoffs: (i) employ at least 50 employees; (ii) have an annual turnover of more than €7.3million; and (iii) report total assets of more than €3.65million. An important difference between the two types of accounts is that full accounts distinguish between total turnover and total material costs, while abbreviated accounts only report value-added (although firms can report turnover and material costs on a voluntary basis if they choose to do so). Hence, whenever we calculate firm-level productivity, measured as labor productivity or total factor productivity, we will use value-added as the preferred measure of output. This implies that labor productivity will be defined as value-added per worker and total factor productivity indices are calculated using a value-added decomposition in each year.

A.2 Foreign Direct Investment Survey

The Foreign Direct Investment Survey data contain information on firms' foreign shareholders and affiliates. Since 2001, only firms with financial fixed assets of more than €5 million or total equity value of more than €10million or a balance sheet total exceeding €25million are required to report. We use the FDI survey to identify firms' foreign shareholders and affiliates.

A.3 Trade Database

The Trade Database covers the full population of firms that reported trading activities in 2005. The data include both import and export flows, at the firm-product-country level. In addition, the data distinguish between intrastat (intra-EU) and extrastat (extra-EU) trade and between different types of transactions (e.g. transactions with transfer of ownership and compensation, transactions involving repairs and return of goods, transactions before processing and repair, etc.).

Whether firms have to report their export transactions, depends on the value and destination of export flows. For intra-EU trade flows, firms have to report their trade on a monthly basis, using an electronic submission system. Firms are only required to report intrastat trade if their value of trade exceeds a particular cutoff. The participation of firms in the intrastat inquiry (pertaining to the intra-EU trade) is determined by statistical thresholds (selection is based on the VAT returns from the previous year). For 2005, firms exporting or importing for more than €250,000 a year have to report their export transactions. Estimations performed by the National Bank of Belgium suggest that total trade reported in the Trade Database accounts for more than 98 percent of total actual exports.

For trade flows destined for countries outside of the European Union (extrastat trade), data are collected from customs records. Usually these data are collected on a transaction basis, though a few companies are exempted and file a monthly declaration with the NBB. The customs declarations are collected on a daily basis and aggregated by the NBB. For extrastat trade, all transactions whose value is higher than €1,000 or whose weight is bigger than 1,000Kg have to be recorded. Each observation represents an export or import flow (intrastat or extrastat) of a particular 8-digit Combined Nomenclature (CN8) product to or from a particular country by an individual firm. We exclude all trade transactions that do not involve a "transfer of ownership with compensation" from the data such as re-exports, the return, replacement and repair of goods, transactions without compensation (e.g. government support), processing or repair transactions, etc.

A.4 Prodcom Database

The Prodcom Database covers the population of firms that declared their production activities in 2005. The data contain firms' production activities at the firm-product level. All firms employing at least 10 people and with primary manufacturing activity are required to report to Prodcom. Firms with primary activity outside the manufacturing sector are only required to report if they employed at least 20 people. Firms below the employment cutoff are only required to report if their turnover exceeds a minimum threshold. Whether or not firms have to file a Prodcom declaration is based on their social security records of the previous year. The Prodcom survey is obligatory and its underlying regulation is EU-based. All EU member states (and some EFTA countries and future accession countries) are bound by the Prodcom regulation.

In the Prodcom declaration, which has to be filed on a monthly basis, firms are required to record their production activities at an 8-digit level. Products are Prodcom products, i.e. they are part of the European Prodcom List. Eurostat has developed the Prodcom List with two principal goals in mind: (i) measure production in the EU member states on a comparable basis and (ii) enable a comparison between production and foreign trade statistics (Eurostat (2006)). In view of the second aim, the Prodcom List has a close relationship with the Combined Nomenclature classification, which is used to record foreign trade statistics. In addition, the Prodcom classification is closely linked to the European NACE and CPA classifications, i.e. the first six digits of the Prodcom codes are CPA codes and the first four digits are NACE codes.

A.5 Merging data

To compare firms' domestic production and trade activities at the product level, we merge the trade and domestic production data obtained from the Trade Database and Prodcom Database respectively. Both databases use firms' VAT number to identify firms, but a different classification system is used to record products. The Trade Database defines products using the Combined Nomenclature (CN8) classification at 8-digit level, while the Prodcom Database defines a product using the Prodcom classification at 8-digit level (PC8). Although there is a close link between the CN and PC classification by construction, the Prodcom list does not cover all products listed in the CN classification and vice versa. Specifically, the Prodcom list does not cover certain CN products (e.g. energy and recycling products), while the CN classification does not cover industrial services (some of which are covered by Prodcom). When we translate both classifications into HS6+ products, we only take products covered by both classifications into account. A detailed discussion of the issues confronted when merging production and trade can be found in Van Beveren et al. (2012).

Firm-level data from the combined Prodcom-Trade data are additionally merged with the Business Registry data and FDI survey data, using the VAT number as the firm identifier. The final data set contains data on all firms that produced at least one product in the Prodcom survey (5465 in 2005). Of these 5465 firms, 3631 are exporters.

Table 1: Summary statistics, 2005

# Exported Products	# Firms	# Produced Products	Exports (million €)	Average exports per firm (million €)	Production (million €)	Average production per firm (million €)	ln(Total Factor Productivity)	ln(Value added)	ln(Employment)
1	574	1.46	1,112	1.94	3,498	6.09	0.02	14.13	3.15
2	387	1.58	1,428	3.69	4,207	10.87	0.05	14.44	3.40
3	289	1.85	1,719	5.95	4,411	15.26	0.04	14.51	3.43
4	261	2.2	2,769	10.61	4,592	17.59	0.03	14.70	3.63
5	202	2.17	3,971	19.66	5,336	26.42	0.06	14.65	3.60
6	222	2.45	2,922	13.16	4,749	21.39	0.10	14.85	3.75
7	175	2.38	4,639	26.51	6,070	34.69	0.07	14.92	3.73
8	128	2.35	1,288	10.06	2,127	16.62	0.11	14.82	3.76
9	131	2.95	5,615	42.86	6,850	52.29	0.08	15.12	4.01
10	105	2.83	1,557	14.83	2,421	23.06	0.08	15.06	3.98
1-5	1,713	1.75	10,999	6.42	22,044	12.87	0.04	14.41	3.38
6-10	761	2.55	16,021	21.05	22,218	29.20	0.09	14.94	3.83
11-15	376	3.06	10,218	27.18	15,385	40.92	0.11	15.16	4.04
16-20	224	3.93	7,766	34.67	11,080	49.46	0.11	15.47	4.29
21-25	134	3.87	3,951	29.49	5,607	41.84	0.15	15.42	4.26
25-30	107	4.80	5,453	50.96	8,022	74.97	0.18	15.68	4.45
1-10	2,474	2.00	27,020	10.92	44,262	17.89	0.05	14.58	3.52
11-20	600	3.39	17,984	29.97	26,465	44.11	0.11	15.28	4.13
21-30	241	4.28	9,404	39.02	13,628	56.55	0.16	15.53	4.34
31-40	104	4.15	4,449	42.77	5,285	50.81	0.26	16.13	4.81
41-50	74	5.28	4,533	61.25	4,085	55.21	0.17	16.20	4.96
>50	138	8.76	21,624	156.70	23,818	172.59	0.35	17.01	5.59
Total	3,631.00	2.76	85,013.72	23.41	117,544	32.37	15.51		

Notes: This table includes all exporters in the Prodcom survey for 2005 that report positive domestic production for at least one of their products. Products are defined as HS6+ products.

Table 2: CAT Firms, Products and Exports: 2005

	HS6+	HS4+	HS2+
Firms with at least 1 CAT product	3,233	3,081	2,745
Firms with at least 1 Pure CAT product	3,177	3,030	2,669
Firms for which CAT products account for at least 5% of exports	2,442	2,114	1,575
Firms for which CAT products account for at least 10% of exports	2,222	1,869	1,373
Firms for which CAT products account for at least 25% of exports	1,867	1,523	1,094
Firms for which Pure CAT is at least 5% of exports	2,124	1,797	1,194
Firms for which Pure CAT is at least 10% of exports	1,854	1,507	954
Firms for which Pure CAT is at least 25% of exports	1,453	1,134	653
Total Products	2,858	1,012	90
Products exported as CAT by at least 1 firm	2,822	999	90
Firm-Products	45,134	34,089	17,643
CAT Firm-Products	39,286	29,118	13,668
Exports of CAT products (million €)	41,475	34,392	31,974
Produced Exports (million €)	59,628	65,373	70,900
Sourced Exports (million €)	25,386	19,641	14,114

Notes: There are 3631 exporting firms. Total exports in the sample amount to €85,014 million. CAT Firms and Firms with at least 1 PURE CAT product are firms that export at least one CAT product and at least one pure CAT product respectively. Total Products is the number of unique products either produced and/or exported and Firm-Products is the total number of unique firm-product pairs either produced and/or exported. CAT Products is the number of products exported as a CAT product by one or more firms and CAT Firm-Products is the number of unique firm-product pairs exported as a CAT product. Exports of CAT products are the total exports of all CAT firm-products respectively. Produced Exports is the produced value of all exported firm-products and Sourced Exports is the non-produced part of all exported firm-products.

Table 3: CN and PC Codes and Descriptions for Sweet Biscuits (Cookies)

CN/HS Code	**Description**
1905 31	Sweet biscuits
1905 31 11	Completely or partially coated or covered with chocolate or other preparations containing cocoa in immediate packings of a net content not exceeding 85 g
1905 31 19	Completely or partially coated or covered with chocolate or other preparations containing cocoa – other
1905 31 30	Containing 8 % or more by weight of milkfats
1905 31 91	Sandwich biscuits
1905 31 99	Other

PC Code	**Description**
10.72.12	Sweet biscuits
10.72.12.53	Sweet biscuits, waffles and wafers completely or partially coated or covered with chocolate or other preparations containing cocoa
10.72.12.55	Sweet biscuits (including sandwich biscuits, excluding those completely or partially coated or covered with chocolate or other preparations containing chocolate)

Notes: The Combined Nomenclature (CN) and Prodcom (PC) classifications are available at ec.europe.eu/eurostat/ramon

Table 4: CAT Facts: Robustness

	Full data	Primary manufacturing firms	Manufacturing only firms	Omitting domestic groups	Omitting multinational groups	Omitting multinational and domestic groups	Omitting HS6+ codes	Subtracting imports at fp-level	Dropping fp with positive imports	Imposing 1% cut-off value
Number of exporting firms	3,631	3,110	2,153	1,922	3,114	1,769	3,485	3,534	3,164	3,631
% of exporters $\geq$1 CAT product	89.0	89.2	89.1	87.9	87.8	86.3	90.9	85.7	89.2	88.9
% of Exporters $\geq$5% CAT	67.3	66.4	69.3	67.7	65.8	66.3	68.7	62.2	78.7	66.7
% of Exporters $\geq$ 10% CAT	61.2	59.9	63.4	62.1	60.2	60.7	62.4	56.2	76.4	60.6
% of Exporters $\geq$ 25% CAT	51.4	50.1	53.7	52.0	50.3	50.7	52.3	47.8	72.2	50.7
% of Exporters $\geq$ 5% Pure CAT	58.5	57.3	60.6	59.9	57.9	59.2	60.0	54.3	74.4	58.7
% of Exporters $\geq$ 10% Pure CAT	51.1	49.5	53.2	52.8	51.2	52.4	52.3	47.7	71.8	51.4
% of Exporters $\geq$ 25% Pure CAT	40.0	38.4	42.1	41.3	40.5	41.6	40.8	38.6	67.3	40.2
Value of sourced exports/total exports	29.9	27.6	27.5	29.1	31.2	36.2	33.5	24.1	32.2	29.9
Exports of CAT products/total exports	48.8	47.7	50.6%	58.5	44.3	50.0	45.8	35.0	37.6	47.6
% of products exported as CAT by $\geq$ 1 firm	98.7	98.7	98.8	98.9	98.8	99.0	98.7	97.8	97.8	98.7
% of export products $\geq$ 5% CAT	90.0	90.0	90.1	90.1	90.1	90.2	89.8	85.0	91.1	89.8
% of export products $\geq$ 10% CAT	86.6	86.5	86.5	86.6	86.6	86.6	86.4	81.5	89.0	86.0
% of export products $\geq$ 25% CAT	80.3	80.2	80.6	80.1	80.3	80.0	81.3	75.3	85.4	79.8
% of export products $\geq$ 5% Pure CAT	83.1	82.9	83.3	83.0	83.1	83.0	84.0	77.8	87.6	83.3
% of export products $\geq$ 10% Pure CAT	77.0	76.9	77.3	76.9	77.0	76.7	78.3	73.3	84.8	77.2
% of export products $\geq$ 25% Pure CAT	68.9	68.7	69.2	68.5	68.7	68.1	72.1	65.9	80.4	69.3
% of exported firm-products that are CAT	87.0	86.4	86.1	86.5	85.2	83.7	87.8	82.7	88.3	86.9

Notes: Products are defined as HS6+ products. Primary manufacturing firms are firms with reported primary activity in NACE (Rev. 1.1) 15 to 37. Manufacturing only firms are firms with no secondary activities outside of manufacturing. Firms are part of a domestic groups if they are part of a Belgian group. Firms are part of a multinational group if they own foreign subsidiaries or if they are a subsidiary of a foreign firm (cut-off percentage in ownership: 20 percent). Omitting HS6+ products amounts to omitting all grouped sets of HS6 codes, such that only one-one and many-one mappings between CN/PC and HS6 are retained. Subtracting imports at the firm-product level implies that only exports that are not covered by imports of the same product by the firm are retained in the data. Alternatively, firm-products with positive imports are dropped from the data altogether. The final column imposes a cut-off in the definitions for regular and CAT exports to account for potential rounding errors in the data, i.e. exports at the firm-product level are considered as regular exports if the ratio of domestic production to exports is higher or equal than 0.99. Similarly, firm-products are considered as pure CAT products if the ratio of domestic production to exports is lower or equal than 0.01.

Table 5: Firm Productivity, CAT and the Margins of Trade

	Panel A: Total Factor Productivity		
	All Exports		
	ln($value_f$)	ln(# $products_f$)	ln(average $value_f$)
Ln(TFP)	1.294***	0.508***	0.785***
	[0.104]	[0.051]	[0.085]
Fixed effects	Industry	Industry	Industry
Clustering	no	no	no
Observations	3,097	3,097	3,097
R-squared	0.153	0.155	0.117

	Panel B: Total Factor Productivity		
	Exports by type (Regular or pure CAT)		
	ln($value_f$)	ln(# $products_f$)	ln(average $value_f$)
$d_{pureCAT}$	-1.574***	1.247***	-2.821***
	[0.070]	[0.025]	[0.063]
Ln(TFP)	1.225***	0.098***	1.127***
	[0.115]	[0.033]	[0.108]
$d_{pureCAT}$* Ln(TFP)	-0.194	0.398***	-0.592***
	[0.163]	[0.061]	[0.143]
Fixed effects	Industry	Industry	Industry
Clustering	firm	firm	firm
Observations	5,173	5,173	5,173
R-squared	0.156	0.366	0.323

	Panel B: Labor Productivity		
	Exports by type (Regular or pure CAT)		
	ln($value_f$)	ln(# $products_f$)	ln(average $value_f$)
$d_{pureCAT}$	-1.532***	1.224***	-2.756***
	[0.069]	[0.024]	[0.063]
Ln(VA/worker)	1.226***	0.080***	1.146***
	[0.105]	[0.022]	[0.103]
$d_{pureCAT}$ * Ln(VA/worker)	-0.215*	0.254***	-0.470***
	[0.124]	[0.046]	[0.116]
Fixed effects	Industry	Industry	Industry
Clustering	firm	firm	firm
Observations	5,724	5,724	5,724
R-squared	0.167	0.360	0.331

Notes: Table reports OLS regression of log export value (total - panel A, regular or CAT - Panels B and C) and its components on log firm productivity, measured as total factor productivity (Panels A and B) or labor productivity (Panel C). Panels B and C include a dummy for the type of exports (regular or CAT) and an interaction. Regular and CAT exports are aggregated at the firm level for columns 1-5 in Panels B and C (a firm with both regular and CAT products features twice). Industry dummies are defined at the two-digit NACE level. Significance levels: *** p < 0.01, ** p < 0.05 and * p < 0.10.

Table 6: Robustness: Firm Productivity, CAT and the Number of Products

	quantity size measure of production	log total production value of the firm	log production value of largest produced product	log total export value of the firm	log export value of largest export product	log blue-collar workers
$d_{pureCAT}$	1.269***	1.226***	1.199***	1.032***	1.050***	0.632***
	[0.025]	[0.025]	[0.025]	[0.024]	[0.025]	[0.071]
Ln(TFP)	0.035***	0.129***	0.059***	0.066***	0.042***	0.129***
	[0.007]	[0.010]	[0.010]	[0.006]	[0.006]	[0.012]
$d_{pureCAT}$* Ln(TFP)	0.036***	0.130***	0.188***	0.186***	0.178***	0.193***
	[0.014]	[0.018]	[0.018]	[0.010]	[0.010]	[0.020]
Fixed effects	Industry	Industry	Industry	Industry	Industry	Industry
Clustering	firm	firm	firm	firm	firm	firm
Observations	3,291	5,173	5,173	5,173	5,173	5,606
R-squared	0.390	0.414	0.399	0.479	0.445	0.418

Notes: Table reports OLS regression of log number of exported products (regular or pure CAT) on a dummy for the type of exports (regular or pure CAT), a proxy for firm productivity and an interaction. The quantity size measure of production is a weighted average of relative log quantity produced for each product made by the firm (relative to the average log quantity across all producers) where the weights are the shares of the product in total firm revenue using average product prices (sales divided by output for all firms that made the product). All productivity proxies are defined relative to the industry mean. Industry dummies are defined at the two-digit NACE level. Significance levels: *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.10$.

Table 7: Export Prices and the Number of Exported Products: 2005

Dependent Variable: Log export price (firm-product-country)				
	OLS	IV	IV	IV
ln(# of products)$_{fc}$	0.023***	0.304***	0.619***	
	[0.010]	[0.109]	[0.194]	
# of products$_{fc}$				0.070***
				[0.026]
Tariff$_{pc}$	-0.001*	-0.001*		
	[0.001]	[0.001]		
Rank (export Q)$_{fpc}$	-0.029***	-0.035***	-0.063***	-0.064***
	[0.001]	[0.003]	[0.006]	[0.007]
First Stage				
(Instrument) Tariff$_{fc}$		-0.010***	-0.013***	-0.113***
		[0.002]	[0.002]	[0.022]
Tariff$_{pc}$		0.001		
		[0.001]		
Rank (export Q)$_{fpc}$		0.022***	0.030***	0.280***
		[0.001]	[0.001]	[0.020]
Number of observations	31035	31035	18784	18784
R-square	0.062	-	-	-
F-stat first-stage regression	-	17.13	54.06	28.05
Country fixed effects	99	99	-	-
Country-Product fixed effects	-	-	6764	6764
Firm-product fixed effects	4573	4573	3946	3946

Note: The number of products is defined as the total number of export products of a firm to a specific destination (including HS6 and HS6+ categories). The estimation sample only includes export flows destined for countries outside the EU (extra-EU exports) and HS6 products (more aggregate HS6+ groups are omitted). Cases where only a single observation features in a fixed effect (country or country-product and firm-product) are omitted from the sample (this explains the lower number of observations when country-product fixed effects are included). Due to the large number of fixed effects, all specifications are estimated in differences (demeaned). Rank (export Q) is the firm's inverse sales rank within each destination country-product market (higher rank corresponds to higher export quantity). Standard errors (and F-statistic in first stage) have been adjusted to take demeaning into account, they are robust and clustered at the firm-product level. The instrument in the first stage regression is the (unweighted) average tariff across all products produced or exported to any destination by the firm and is defined at the firm-country level. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 8: Export Prices of CAT Products and Firm Productivity

	[1]	[2]
	OLS	OLS
TFP	0.037	0.055
	[0.035]	[0.041]
Destination-product fixed effects	no	yes
Observations	57200	57200
R-square	0.000	0.2071

Note: The dependent variable is the percentage difference of the price of the pure CAT product from the average price of the product in the market. The average price is calculated only using pure CAT exports of the product. Column [1] includes only firm productivity; column [2] includes firm productivity and destination-product fixed effects. Robust standard errors, clustered (two-way) at the firm and product-country level, are in parentheses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.